

NEW CUCUMARIID HOLOTHURIANS (ECHINODERMATA) FROM SOUTHERN AUSTRALIA, INCLUDING TWO BROODING AND ONE FISSIPAROUS SPECIES

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Abstract

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Twelve new species of cucumariid holothurians are described from off the coast of southern Australia. *Pentocnus* gen. nov. is erected for one species which has no interradial plates in the calcareous ring. *Cucuvitrum* gen. nov. (1 species), *Squamocnus* gen. nov. (1 species) and *Apsolidium* gen. nov. (3 species) are erected for species with combinations of body and ossicle form not represented in known genera. The other species are assigned to *Neocnus*, *Trachythone* (2 species), *Ocnus*, *Neocucumis* and *Neocucumella*. The new species of *Pentocnus* and *Neocnus* brood their young. The new species of *Squamocnus* is fissiparous. The new species of *Cucuvitrum* is host to a copepod parasite (Cucumariolidae).

Introduction

Southern Australian holothurians are known mainly from the works of Ludwig (1874), Bell (1887), Joshua (1912, 1914), Joshua and Creed (1915), Erwe (1913), H.L. Clark (1914, 1938, 1946), Hickman (1962, 1978), A.M. Clark (1966), Rowe (1976, 1982) and Rowe and Vail (1982). Including those described herein, 23 cucumariid species are now known from the Australian states of Victoria, Tasmania, South Australia and from the south-west of Western Australia (Table 1). Of these, 5 are abundant and well known for the region: *Psolidiella adhaerens* Hickman, 1962, *Staurothyone inconspicua* (Bell, 1887), *Pentacta ignava* (Ludwig, 1874), *Cucumella inutans* (Joshua, 1914) and *Neoamphicyclus lividus* Hickman, 1962. These have been described in detail by Hickman (1962) (*P. ignava* as *P. australis*), and current distribution and habitat notes given by one of the us (M.O'L.) in Marine Research Group of Victoria (1984). *Amphicyclus mortenseni* Heding and Panning, 1954, also described by Hickman (1962), occurs in deeper water in eastern Bass Strait.

Some essentially tropical species extend around the coast of Western Australia into the Great Australian Bight (Rowe, 1982). These are: *Mensamaria intercedens* (Lampert, 1885); *Pentacta crassa* (Ekman, 1918); *Pentacta quadrangularis* (Troschel, 1846); and *Pentacta anceps* (Selenka, 1867). *Cucumaria bicolor* Bell, 1887 (see Heding and Panning, 1954: 92) and *Cucumaria striata* Joshua and Creed, 1915 (see A.M. Clark, 1966: 345) have been referred to the synonymy of *Mensamaria intercedens*.

Joshua (1914) recorded the Indo-Pacific cucumariid *Plesiocolochirus spinosus* (Quoy and Gaimard, 1833) from "Victorian waters". The ill-defined locality data with the specimens in the Museum of Victoria create doubt about its occurrence in the region.

Joshua (1914) and Joshua and Creed (1915) recorded from southern Australia the New Zealand species *Pseudocucumis* (= *Neocucumella*) *bicolumnatus* (Dendy and Hindle, 1907), the South American species *Cucumaria* (= *Neopsolidium*) *convergens* (Herouard, 1901), and the subantarctic species *Cucumaria* (= *Trachythone*) *squamata* (Ludwig, 1898). Rowe (1982) recorded *Ocnus calcareus* (Dendy, 1896) from off south-western Australia. This material has been re-examined by us and in all four cases has been assigned to new species. H.L. Clark (1946: 389) proposed the name *Cucumaria squamatoidea* for the specimen of *C. squamata*, but, as A.M. Clark (1966: 345) pointed out, this name is a nomen nudum, failing to meet the criteria under ICZN Article 13 and is replaced herein.

Extensive collecting of echinoderms from the southern Australian coast by us and with associates since 1978 has revealed many new holothurian species. Most of the specimens were collected off algae or rocks in the rocky shallows, in depths of 0–2 m, and representatives of these species were observed live before preservation. Other specimens, including material from the continental shelf, were examined from the collections of the Museum of Victoria (NMV), the Australian Museum (AM), the South Australian Museum (SAM), the Western Australian

Museum (WAM), the Tasmanian Museum (TM), the New Zealand Oceanographic Institute (NZOI) and the Museum of Comparative Zoology, Harvard (MCZ).

Two of the new species brood their young: the *Neocnus* species in two marsupia in the anterior dorsal body wall, and the *Pentocnus* species in pouches on the internal anterior body wall. Seasonal coelomic brooding has been reported for two south-eastern Australian cucumariids: *Staurothyone inconspicua* (Bell, 1887) and *Neoamphicyclus lividus* Hickman, 1962 (see Materia et al., 1991).

Terminology

Terminology predominantly follows Clark and Rowe (1971) or Pawson (1970). Ossicle types include cups (pl. 4c), rosettes (pl. 7f), tables (fig. 8c), buttons (pl. 9a), plates (pl. 7d), multi-layered ossicles (pl. 3b), pedicel endplates (pl. 6g), bar-like ossicles (pl. 9e), mesh-like ossicles (small plates in pl. 6h) and rods (pl. 2h). All podia or tube feet are referred to as pedicels. A sole is a flattened, delimited modification of the ventral body wall with peripheral pedicels which do not extend to the introvert or anus (pl. 2b). The term radii is used in preference to ambulacra (following Pawson, 1970). Left and right are relative to facing anteriorly along the dorsal surface.

Order *Dendrochirotida* Grube, 1840
(restricted by Pawson and Fell, 1965)

Cucumariidae Ludwig, 1894

Remarks. The relationships between "cucumariid" and "phyllophorid" holothurians have been confused. Panning (1949) and Heding and Panning (1954) define the Cucumariidae and the Phyllophoridae predominantly on the basis of the number of tentacles, ten in the Cucumariidae and more than ten in the Phyllophoridae. Pawson and Fell (1965) consider that the nature of the calcareous ring is fundamental, placing genera with posterior processes in the Phyllophoridae and those without in the Cucumariidae. However, Clark and Rowe (1971), Hickman (1978) and Cannon and Silver (1987) have continued to use the older basis for classification. Pawson and Fell's classification is used in this paper. Consequently the subfamily Thyonidiinae (e.g., *Cucumella* Ludwig and Heding, 1935 and *Neoamphicyclus* Hickman, 1962) with 15–30 tentacles and simple calcareous ring is included in the Cucumariidae, and the subfamily Thyoninae (e.g. *Thyone* Oken,

1815) with ten tentacles and conspicuous posterior processes on the calcareous ring is considered to be in the Phyllophoridae.

The taxonomy within the Cucumariidae is also currently confused and ill-defined, particularly between the subfamilies Colochirinae and Cucumariinae. Panning (1949), in his revision of the Cucumariidae (which included the final breakup of old heterogeneous taxa such as *Cucumaria* de Blainville, 1834 and *Thyone* Oken, 1815), distinguished the Colochirinae from the Cucumariinae by the presence of cup-shaped ossicles in the body wall of the former. However, many of the species in the Cucumariinae, as then defined, were subsequently found to have cups or cup-like derivatives, or at least plates similar in form to genera in the Colochirinae. Panning (1971) finally restricted the Cucumariinae to two genera, *Cucumaria* and *Cladodactyla* Brandt, 1835 without, however, publishing emended diagnoses for these genera or either subfamily.

Panning (1962, 1964, 1966, 1971) further restricted the diagnoses of many of the genera within the Colochirinae. Consequently recent regional studies (Rowe, 1970; Rowe and Pawson, 1985; Thandar, 1985, 1986, 1987; Gutt, 1990; this paper) have added a plethora of new genera as new or existing species could no longer be satisfactorily placed in existing genera. This has led to a more natural classification, recognizing structural differences between ossicle types, but more research is necessary, particularly on the derivation of the various cup ossicles.

Panning (1971) attempted to divide the Colochirinae into three distinct groups, based on the number of ossicle types present and their function. An "Oenus" group with two types of body wall ossicles, a "Pentacta" group with three, and the genus *Pseudocnus* with special denticulate plates which function as cups, giving the skin adhesive traction. But this division is unnatural as many of the species in the "Oenus" group have three types of body wall ossicles, not the two required, and *Pseudocnus* is not the only genus to use denticulate body wall plates to achieve traction.

The phylogeny of the Cucumariidae poses many problems, particularly due to the apparent incidence of convergent evolution. Panning (1971), mainly after Pawson (1966), listed the following characters as primitive: posterior extensions on the calcareous ring; pedicels restricted to the radii; and an imbricating armour of multi-layered scale-like ossicles

Table 1. Nomenclatorial history of southern Australian cucumariid species.

This Paper	Rowe, 1982	H.L. Clark, 1946	Joshua, 1914 Joshua and Creed, 1915
Colochirinae			
<i>Staurothyone inconspicua</i> (Bell, 1887)	<i>Staurothyone inconspicua</i>	<i>Staurothyone inconspicua</i>	<i>Cucumaria inconspicua</i>
<i>Pentocnus bursatus</i> gen. et sp. nov.	<i>Pseudocnus</i> sp.		
<i>Cucutivitrum rowei</i> gen. et sp. nov.			
<i>Neocnus binarsuptis</i> sp. nov.	<i>Psolidiella adhaerens</i>		
<i>Psolidiella adhaerens</i> Hickman, 1962			
<i>Squamocnus aureoruber</i> gen. et sp. nov.			
<i>Trachythyone candida</i> sp. nov.	<i>Trachythyone</i> sp.	<i>Psolidium</i> sp.	<i>Psolidium convergens</i> (Herouard, 1901)
<i>Trachythyone gleboxa</i> sp. nov.			
<i>Apsolidium handrecki</i> gen. et sp. nov.			
<i>Apsolidium densum</i> sp. nov.			
<i>Apsolidium alvei</i> sp. nov.			
<i>Ocnus occidius</i> sp. nov.			
<i>Pentacta ignava</i> (Ludwig, 1874)	<i>'Cucumaria' squamatoides</i>	<i>Cucumaria squamatoides</i> H.L. Clark, 1946	<i>Cucumaria squamata</i> Ludwig, 1898
<i>Pentacta crassa</i> (Ekman, 1918)	<i>Ocnus calcareus</i> (Dendy, 1896)	<i>Pentacta australis</i> (Ludwig, 1874)	<i>Colochirus doliolum</i> (Pallas, 1766)
<i>Pentacta quadrangularis</i> (Troschel, 1846)	<i>Pentacta ignava</i>	<i>Pentacta crassa</i>	<i>Colochirus quadrangularis</i> Lesson, 1830
<i>Pentacta anceps</i> (Selenka, 1867)	<i>Pentacta quadrangularis</i> (Lesson, 1830)	<i>Pentacta quadrangularis</i> (Troschel)	
<i>Plesiocolochirus spinosus</i> (Quoy and Gaimard, 1833)	<i>Pentacta anceps</i>	<i>Apentacta spinosa</i>	<i>Colochirus spinosus</i>
Thyonidiinae			
<i>Amphicyclus mortenseni</i> Heding and Panning, 1954	<i>Plesiocolochirus spinosus</i>		
<i>Neoamphicyclus lividus</i> Hickman, 1962	<i>Amphicyclus mortenseni</i>	<i>Mensanaria thomsoni</i> (Hutton, 1879)	<i>Cucumaria mutans</i>
<i>Cucumella mutans</i> (Joshua, 1914)	<i>Neoamphicyclus lividus</i>	<i>Mensanaria thomsoni</i> (Hutton, 1879)	<i>Cucumaria striata</i>
<i>Mensanaria intercedens</i> (Lampert, 1885)	<i>Cucumella mutans</i>	<i>Mensanaria intercedens</i> <i>Cucumaria striata</i> Joshua and Creed, 1915 <i>Cucumaria</i> <i>bicolor</i> Bell, 1887	
<i>Neocucumella fracta</i> sp. nov.	<i>Mensanaria intercedens</i>		<i>Pseudocucumis</i> <i>bicolumnatus</i>
<i>Neocucumis cauda</i> sp. nov.	<i>Neocucumella bicolumnata</i> (Dendy and Hindle, 1907)	<i>Mensanaria bicolumnata</i>	

covering the whole body. No extant cucumariid genus has all of these characters, but some genera, e.g., *Leptopentacta* H.L. Clark, 1938, do possess small extensions to the radial plates in the calcareous ring, and non-imbricating multi-layered ossicles.

Colochirinae Panning, 1949

Pentocnus gen. nov.

Diagnosis. Worm-like form, lacking solc or modified ventrum; 10 irregularly developed dendritic tentacles; calcareous ring discontinuous, 5 spaced radial plates without posterior prolongations, no interrarial plates; pedicels present on all radii, absent interradially. Body wall ossicles small, elongate, perforated, flat or saucer-like, often denticulate plates, with blunt vertical spines; lacking true cups; pedicels with similar plates to body wall, and endplates; tentacles with irregular perforated bar-like ossicles, small perforated plates and rods.

Type species. *Pentocnus bursatus* sp. nov.

Etymology. From the Greek *pente* (five), in reference to the plates in the calcareous ring, with *Ocnus* (masculine).

Remarks. The lack of interrarial plates in the calcareous ring, the irregular development of the tentacles, the delicate form of the ossicles, and the other possible pedomorphic characters,

clearly distinguish *Pentocnus* from all other genera within the Cucumariidae. The shallow, saucer-like, spined form of the plates suggests a possible form or functional relationship with the cup ossicles present in other cucumariid genera. The denticulate body wall plates possibly indicate some relationship with the genus *Pseudocnus* Panning, 1949.

Some cucumariid genera have reduced interrarial calcareous ring plates, but no other dendrochirotid genus lacks them completely. In the subfamily Thyonidiinae, *Athyonidium* Deichmann, 1941 has very reduced interradials, often obscured by muscle; the resulting ring is also discontinuous. In *Amphicyclus* Bell, 1884 the interradials are also reduced, but they adjoin the larger radial plates in a continuous ring.

Pentocnus bursatus sp. nov.

Plates 1a, 2e-g, Figure 1

Pseudocnus sp. — Rowe and Vail, 1982: 224.

'cucumariid' sp. — O'Loughlin, 1991: 225–226, fig. 4.

Material examined. Holotype, Victoria, Cape Paterson, rocky shallows, algal and sponge epifauna, 14 Feb 1981, M. O'Loughlin, M. Nyhuis and C. Walker, NMV F57549.

Paratypes, Victoria, Cape Paterson, type locality and date, AM J22754(1); NMV F58629(1 juv); 18 Jan 1980, NMV F54236(1); rocky shallows, algal epifauna, 6 Mar 1983, NMV F53762(1); 29 Jan 1988, NMV F54181(1).

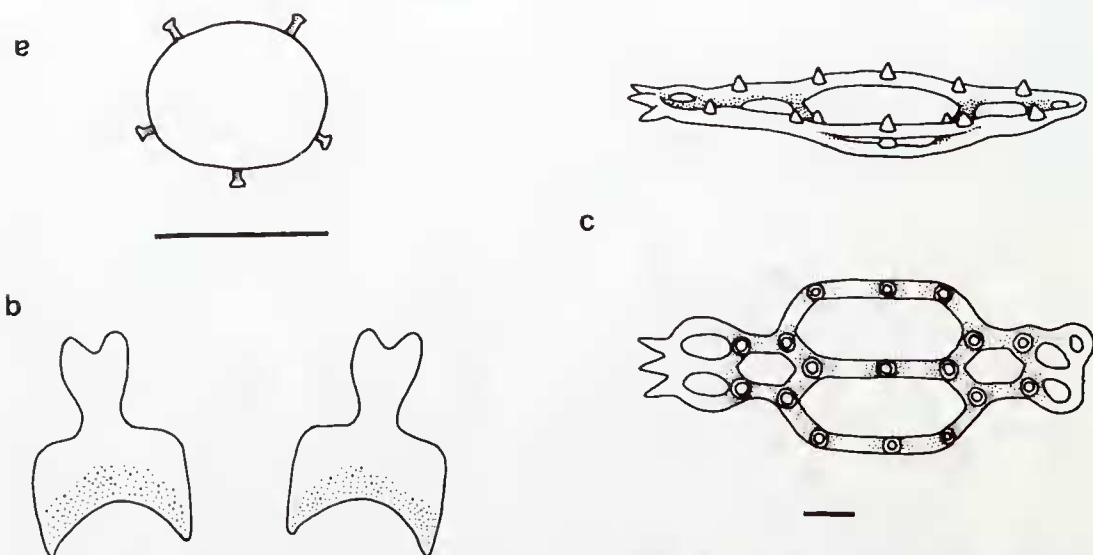


Figure 1. *Pentocnus bursatus* gen. et sp. nov.: a, transverse section of body, scale bar = 1.0 mm; b, 2 adjacent radial plates from the calcareous ring; c, side and top view of a dorsal body wall plate, scale bar = 0.01 mm.

South Australia, Beachport, 37°29.3'S, 139°59.6'E, 4 m, 14 May 1990, NMV F59207(1).

Other material. Western Australia, Rottnest I., Cape Vlamingh, outer reef flat, 9 Jan 1991, WAM 239-91(1); Radar Reef, *Sargassum/Cystophora* mat, 13 Jan 1991, WAM 255-91(1).

Description. Up to 15 mm long (live, extended), 1 mm wide; body worm-like, round in transverse section, lacking sole or modified ventrum, introvert not distinct, mouth anterior, anus posterior; body wall thin, very extensible; 10 dendritic tentacles, very irregularly developed, about 6 fully developed, about 4 small or bud-like. One row of pedicels on each radius, with up to 18 pedicels in a row, slightly more numerous ventrally; inter-radial areas lacking pedicels. Calcareous ring comprises 5 spaced radial plates, no interrational plates; no posterior prolongations; anterior projections constricted basally, widened and rounded distally with apical notch; wide, deep, rounded notch posteriorly, creating pairs of pointed projections (the 5 plates of the calcareous ring are clearest in specimens NMV F57549, NMV F53762, NMV F59207, WAM 239-91.) Dorsal madreporite; single, left to ventral, polian vesicle.

Body wall ossicles of one type: small, clongate, perforated plates, with blunt vertical spines, often denticulate, flat or shallow saucer-like, up to 0.09 mm long; typical plate with 2 large central holes, one smaller hole near each end, 1–6 very small holes at ends; plates frequently denticulate at one end or one side; ossicles may imbricate or be spaced in extended body wall. Pedicels with body wall plates; endplates with irregular angular perforations, about 0.1 mm wide. Tentacles with small irregular plates with large angular perforations, up to 0.07 mm wide; abundant irregular rods with divided, twisted, perforated ends, sometimes branched, typically 0.07 mm long; a few large, irregular, branched, perforated bar-like ossicles, up to 0.13 mm long; a few elongate rosettes up to 0.05 mm long; some body wall plates, lacking spines.

Live colour. Body and pedicels reddish brown; end rim of pedicels dark reddish brown; tentacle trunks brown, branches faintly reddish brown; colour persists in alcohol.

Reproduction. The holotype (6 mm long, tentacles withdrawn) has a dorsal gonad, 1 brood embryo and 1 brood juvenile. The gonad has 5 sac-like caeca, graded in size, the smallest caeca with 1–2 small white eggs, the largest caecum with 1 brown egg or embryo (0.3 mm long). The brood embryo is dark brown, ovoid, undifferen-

tiated (0.8 mm long). The brood juvenile is well-differentiated (1.4 mm long). Both are together in the coelom in a membranous sac which is attached to the anterior, left ventral body wall. There is no change in the body wall at the point of attachment, nor any apparent aperture to the exterior.

NMV F54236 (10 mm long, tentacles withdrawn) has a dorsal gonad, 3 brood embryos and 2 juveniles. The gonad has 6 sac-like caeca, graded in size, the 3 smallest with about 3 small white eggs, and the 3 largest each with one large developing brown egg or embryo (up to 0.8 mm long). One brood embryo is in the coelom near the gonad. Two other brood embryos showing radial pedicels, and 2 well-developed brood juveniles (up to 2.3 mm long) are associated with a thin-walled sac in the anterior left lateral coelom. The sac is attached to the interrational body wall where there is a body wall fold and opening. NMV F54181 (8 mm long) has 2 undifferentiated embryos with firm brown ovoid cases (1 mm long). Each embryo is in a thin-walled sac which has a small growth attachment to the coelomic body wall. One is in the left dorsolateral mid-body, the other in the right ventral anterior. At the point of attachment of the anterior embryo the body wall has broken down to create a small opening. A gonad with a few small white eggs is present. AM J22754 (8 mm long, tentacles not withdrawn) has 2 undifferentiated embryos (one in a gonad caecum, 0.7 mm long), an embryo with radial pedicels, and a well-developed juvenile (2.2 mm long) in a membranous sheath in the left anterior coelom. NMV F53762 (5 mm long) had 3 brood embryos (up to 1.5 mm long) in separate thin sacs attached to a scar or fold in the body wall, one in the right dorsolateral coelom in the mid-body, 2 close together in the left ventrolateral coelom anteriorly. There is only part of the gonad remaining. NMV F59207 (5 mm long; tentacles withdrawn) has one well-developed bursal juvenile attached to the right anterior intracoelomic body wall, and a gonad with one large and a few small white eggs.

Etymology. From of the Greek *bursa* (purse), with reference to the intracoelomic sacs in which brood juveniles develop.

Distribution. Rottnest I., Western Australia, to Cape Paterson, Victoria. 0–4 m.

Remarks. This very small species reproduces by brooding in intracoelomic sacs which are randomly attached to the anterior body wall.

Embryos or juveniles may be present singly or together in the saes. The very thin-walled saes lack ossicles and appear to be derived from the egg rather than from the body wall. At the point of attachment of the saes, with their developing embryos or juveniles, the body wall may undergo change, is sometimes gathered into a small fold, and may break down to create a small opening. Individuals produce few eggs but may have all reproductive stages present, from small egg to fully-developed brood juvenile. Only one egg appears to mature at any one time. All six adults exhibit bursal coelomic brooding. All observed gonads contain eggs and are similar in form, suggesting hermaphroditic or pathenogenic reproduction. The collection of brooding adults in January, February, March and May suggests non-seasonal reproduction.

Ocnus sacculus Pawson, 1983, from New Zealand, has a similar brooding habit. Intracoelomic saes are attached to the dorsal interradii anterior body wall and contain up to 9 embryos. The internal sac walls are thin and transparent. The body wall forming the external wall of the sae has fewer ossicles than elsewhere, and Pawson (1983: 228) suggests that "birth" occurs by rupture of the body wall. This species is easily distinguished from *P. bursatus* by the form of the calcareous ring, the form of the ossicles, body form, and distribution of pedicels.

P. bursatus, known from only three widely separated localities, is found amongst algal tufts and sponge in the rocky shallows.

Cucuvitrum gen. nov.

Diagnosis. 10 dendritic tentacles, ventral 2 smaller; pedicels mostly confined to radii, a few scattered on dorsal and lateral interradii. Body wall ossicles numerous knobbed perforated plates, irregularly oval, some with the end or one side denticulate, some large multi-layered ossicles; tentacles and pedicels with bar-like perforated ossicles; pedicels with endplates. Calcareous ring simple, without posterior prolongations; 10 plates tapered anteriorly, notched posteriorly.

Type species. *Cucuvitrum rowei* sp. nov.

Etymology. From the Latin *vitrum* (glass), in reference to the glassy multi-layered ossicles in the body wall, with part of the family name, Cucumariidae (neuter).

Remarks. The combination of the following characters – knobbed plates, multi-layered ossicles, pedicels mostly confined to radii, and ven-

tral tentacles reduced – does not exist in any previously described eucumariid genus and warrants the creation of a new taxon. Of the other genera, *Pseudocnus* Panning, 1949 and *Pseudocnella* Thandar, 1987, are most similar. However, *Pseudocnus* lacks multi-layered ossicles and *Pseudocnella* has ten equal tentacles, interradii papillae, and reduced cups.

Cucuvitrum rowei sp. nov.

Plates 1b, 3a–g, Figure 2

Stereoderma sp. — A.M. Clark, 1966: 346–347, fig. 9.

Pseudocnus sp. — Rowe, 1982: 466, fig. 10.32b, pl. 32.2. — Rowe and Vail, 1982: 223.

Material examined. Holotype. Victoria, Cape Paterson, just below low tide level, 18 Jan 1980, M. O'Loughlin, T. O'Hara and J. Stephenson, NMV F57356.

Paratypes. Victoria, type locality and date, NMV F54241(5); Apollo Bay, Marengo, Hayley Point, just below low tide level, 11 Jan 1980, NMV F54240(2).

Other material (partial list; all found as algal epifauna, 0–2 m, unless otherwise stated; # indicates material with intracoelomic copepod parasites).

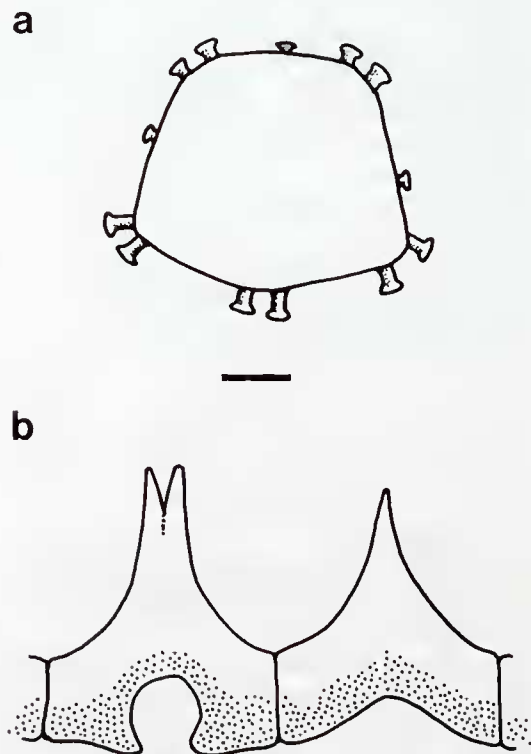


Figure 2. *Cucuvitrum rowei* gen. et sp. nov.: a, transverse section of body, scale bar = 1.0 mm; b, radial and interradii plates from the calcareous ring.

Western Australia, Rottnest I., Strickland Bay, 20 Jan 1991, WAM 400-91(1 juv); Natural Jetty, 15 Jan 1991, WAM 393-91(1 juv); Cape Naturaliste, Eagle Bay, 25 Feb 1975, WAM 556-89(13).

South Australia, Ceduna, Cape Vivonne, 16 Jan 1991, NMV F59209(4); Streaky Bay, Point Westall, 15 Jan 1991, NMV F59211(1); Greenly I., 28 Nov 1976, SAM K1800(1); Arno Bay, 22 Feb 1988, 2-3 m, SAM K1813(1); Kangaroo I., Emu Bay, 17 Jan 1990, NMV F57550(1); Gulf St Vincent, Normanville, 11 Nov 1988, NMV F54386(1); Robc, 9 Jan 1990, NMV F57551(1).

Victoria, Cape Otway, Crayfish Bay, 31 Dec 1980, NMV F54221(1 and 1 juv); 10 km NE of Apollo Bay, "Mullet Holes", 6 Jan 1981, NMV F57949(4); NMV F57948(1#); 10 Jan 1987, NMV F54218(5); NMV F58640(1#); Port Phillip Bay, Altona, 14 Sep 1980, NMV F54228(8); NMV F58641(1#); Williamstown, 11 Apr 1990, NMV F58643(1#); NMV F59208(5); 38°17'S, 144°38'E, 3-6 m, 30 Mar 1986, SPSS stn 3B1, NMV F57547(6#); Portsea Jetty, 4 m, 13 Mar 1975, AM J10857(1); Cape Schanck, Bushrangers Bay, 28 Mar 1981, NMV F54224(3 juv); Flinders, Mushroom Reef, 16 Nov 1990, NMV F59206(1); Merricks, 27 May 1989, NMV F54395(2); Phillip I., Kitty Miller Bay, 13 Feb 1988, NMV F54215(5); 1 km E of Harmers Haven, 300 m offshore, 4.5-6 m, 6 Mar 1982, CPA stn 15, NMV F53772(2); Cape Paterson, 28 Apr 1989, NMV F54394(5); NMV F58642(1#); Shack Bay, 4.5-12.2 m, 4 Mar 1982, CPA stn 4, NMV F53771(1); Wilsons Promontory, Hobbs Head, 12.5 m, 9 Feb 1982, WPNSA stn 42, NMV F53773(1 juv); Rabbit I., 23 Apr 1983, NMV F53783(2); eastern Bass Strait, 39°0'S, 147°30.5'E, 28 m, 28 Jan 1971, NMV F59203(1); Cape Everard, 8 Apr 1984, NMV F57943(2); Mallacoota, Bastion Point, 5 m, 6 Apr 1989, NMV F57363(6); Gabo I., 4 m, 4 Apr 1989, NMV F57364(1).

Tasmania, King I., Rocky Cape, 2 m, 15 Mar 1988, NMV F57361(5); Lulworth, Black Rock Point, 22 Nov 1982, NMV F53788(2); Waterhouse Passage, 23 Nov 1982, NMV F53789(2); Bicheno, 7 m, 22 Mar 1988, NMV F57544(4); Swansea, 8 km S, 4 m, 21 Mar 1988, NMV F57360(5); NMV F57548(2#); Eaglehawk Neck, 15 Feb 1991, NMV F59216(1); Tinderbox, 29 May 1974, AM J10855(1); D'Entrecasteaux Channel, Esperance Point, 13 m, AM J22665(7#); Bruny I., Adventure Bay, 15 m, 23 Apr 1991, AM J22667(3#); Sadgrove Point, 7 Mar 1974, AM J10856(1); Southport, Lady Bay, 3 m, 11 Oct 1977, AM J11164(1).

New South Wales, Disaster Bay, Green Cape Light-house, 16 m, 13 Feb 1973, AM J12548(1); Twofold Bay, 3 m, 29 Mar 1985, AM J19909(6); Eden, Cocora Point, 25 Nov 1984, NMV F53786(3); Jervis Bay, 3 m, 26 Nov 1971, AM J12547(1); Bondi, 3-5 m, Oct 1977, AM J11167(5); Port Jackson, 3 m, 29 Aug 1977, AM J10883(2); Manly, 9 Oct 1979, AM J12735(2); Nambucca Heads, 13 m, 11 Jan 1972, NMV F57555(1#); Coffs Harbour, 13 m, 22 Jan 1982, AM J15470(2).

Description. Up to 21 mm long (tentacles partly withdrawn), 4 mm wide and high; body

elongate, slightly keeled midventrally, distinct dorsolateral and ventrolateral edges, body pentagonal in transverse section; weakly developed oral valves formed by anterior radial body wall projections; mouth orientated anteriorly; extensible anal cone, often upturned; body wall firm, crystalline, with microscopic vitreous spots; 10 dendritic tentacles, 2 ventral ones distinctly smaller; distinct modified ventrum, not a sole; distinct introvert, lacking pedicels; 5 anal teeth. Pedicels in 2 rows on all radii, extending to introvert and anus; ventrolateral and midventral radii with up to 60 pedicels in each row; dorsolateral series irregular, pedicels small; a few small pedicels interradially on dorsal and lateral surfaces, used for grit attachment; single very extensible small pedicels on each radius anteriorly and around anus. Calcareous ring lacking posterior prolongations; 5 radials with blunt anterior projections, often notched, large notch posteriorly; interradials with pointed anterior projections, wide shallow posterior scallops. Madreporite dorsal; single polian vesicle left lateral; intestine runs dorsally from mouth to mid-coelom, loops left back to mouth, then runs ventrally to anus.

Dorsal body wall ossicles of 5 types: 1) Abundant perforated plates, heavily knobbed, irregularly oval, frequently thick and rounded at an end or edge, the opposite side or end denticulate; some plates fir-cone shaped, wide end smooth, narrow end denticulate; many plates with projections, bars, further developing layers, commonly up to 0.12 mm long; closely situated in 2 or more layers within the body wall. 2) Scattered large multi-layered ossicles, irregularly oval, up to 0.48 mm long, with 3-5 perforated knobbed layers of decreasing size, one end sometimes denticulate. 3) A few irregular smooth perforated plates, up to 0.12 mm long. 4) A few irregular smooth or lumpy or knobbed button-like ossicles, typically 0.07 mm long. 5) Rosettes in some New South Wales specimens (AM J10883, AM J12735), up to 0.04 mm long. Plates of ventrum similar to dorsum; multi-layered ossicles less developed. Plates of introvert fewer, similar to body wall, more finely knobbed, none multi-layered. Pedicels with irregular, bent or curved, perforated bar-like ossicles, often widened centrally, often denticulate and finely knobbed along outer edge, typically 0.14 mm long; end-plates up to 0.25 mm wide, smaller perforations centrally; irregularly triangular, perforated, curved, denticulate plates, typically 0.1 mm wide; sometimes rosettes, 0.04 mm long. Tentacles with flat to bar-like thick ossicles,

elongate, irregular, often widened centrally, perforated centrally and distally, sometimes curved, often bent at centre, up to 0.26 mm long; irregularly round to triangular, thin, perforated, slightly convex, denticulate plates, up to 0.08 mm wide; rosettes, typically 0.04 mm long.

Live colour. Body predominantly white, golden in largest specimen, sometimes dark flecking dorsally and laterally; dark vitreous spots dorsally and laterally; tentacle branches pale yellow to golden, with brown to black marking on tentacle trunks extending to varying degrees onto introvert. Gold, yellow colours lost rapidly in alcohol.

Reproduction. Some sac-like gonad caeca and gonoducts have been observed in the right dorsolateral coelom. Most of the many specimens are juveniles, and have been collected during summer and autumn.

Etymology. Named in recognition of the contribution by Dr F.W.E. Rowe to this paper and to echinoderm research in Australia.

Distribution. Rottneest I., Western Australia, to Coff's Harbour, New South Wales, including Tasmania. 0–28 m.

Remarks. One, rarely two, copepod parasites are sometimes present in the coelom of *C. rowei* specimens from Victoria, New South Wales and Tasmania (see # in Material examined for exact locations). Dr G.C.B. Poore (Museum of Victoria, pers. comm.) has provisionally identified them as *Cucumaricola* sp. in the family Cucumaricolidae. They are long and narrow, sometimes extending more than half the length of the coelom, and carrying numbers of yellow eggs.

Rosette ossicles are present in the body wall of some material from New South Wales. These specimens are otherwise similar to those from other regions, and to specimens from New South Wales without rosettes, and are thus included in the current species.

Most of the specimens have been collected as algal epifauna and are juveniles. A few adults have been found attached to the undersurface of rocks.

Neocnus Cherbonnier, 1972

Diagnosis (emended from Cherbonnier, 1972). Body short and stout with distinct sole; 10 dendritic tentacles, ventral 2 smaller; pedicels confined to periphery and mid-ventral radius of sole. Body wall ossicles rare, a few perforated

rods or plates present posteriorly. Tentacles with thin perforated rods; pedicels without endplates. Calcareous ring simple, without posterior prolongations, 10 plates, tapered anteriorly, undulating posterior edge. Dorsal marsupia present.

Type species. *Neocnus incubans* Cherbonnier, 1972.

Remarks. This genus was previously known only from the type species found on the Mediterranean coast off Tunisia.

Two superficially similar genera, *Pseudopsolus* Ludwig, 1898 and *Microchoerus* Gutt, 1990, also have simple ossicles, a sole, and pedicels predominantly restricted to the ventral radii. However, *Pseudopsolus* also has ten equal tentacles, four polian vesicles, rare or numerous, knobbed or smooth perforated plates in the body wall, and is hermaphroditic. *Microchoerus* has knobbed perforated plates, which reduce in density as body size increases, and lacks dorsal marsupia.

Orbithyone H.L. Clark, 1938, known only from the type species *O. megapodia* H.L. Clark, 1938, found off Western Australia, is also characterized by an almost total lack of ossicles. However, it differs in having a distinctive calcareous ring, numerous rosettes as well as rods in the tentacles, no sole, and numerous large pedicels with well-formed endplates covering the whole body.

Neocnus bimarsupii sp. nov.

Plates 1c, 2h, Figure 3

Neocnus sp. — Rowe and Vail, 1982: 224. — O'Loughlin, 1991: 223–225, figs 2, 3.

Material examined. Holotype, Victoria, Apollo Bay, Marengo, Hayley Point, just below low tide level, 29 Dec 1979, M. O'Loughlin, NMV F54238.

Paratypes. Type locality, NMV F54239(120); AM J22752(20).

Other material (partial list; all collected as algal epifauna, 0–2 m, unless otherwise stated).

South Australia, Robe, 10 Jan 1988, NMV F54183(40).

Victoria, Cape Bridgewater, 20 Jan 1979, NMV F53806(1); Cape Otway, Crayfish Bay, 31 Dec 1980, NMV F53814(47); Apollo Bay, Marengo, Hayley Point, 11 Jan 1980, NMV F53808(75); Flinders, east of Mushroom Reef, 13 Jul 1990, NMV F58630(7); Shoreham, 18 Oct 1980, NMV F53813(4); Phillip I., E of Pyramid Rock, 22 Dec 1980, NMV F53810(1); Kilda, 26 Jan 1987, NMV F53805(13); Harmers Haven, 300 m offshore, 4.5–6 m, 6 Mar 1982, CPA stn 15, NMV F53781(1); Cape Paterson, 29 Jan 1988, NMV F54182(8).

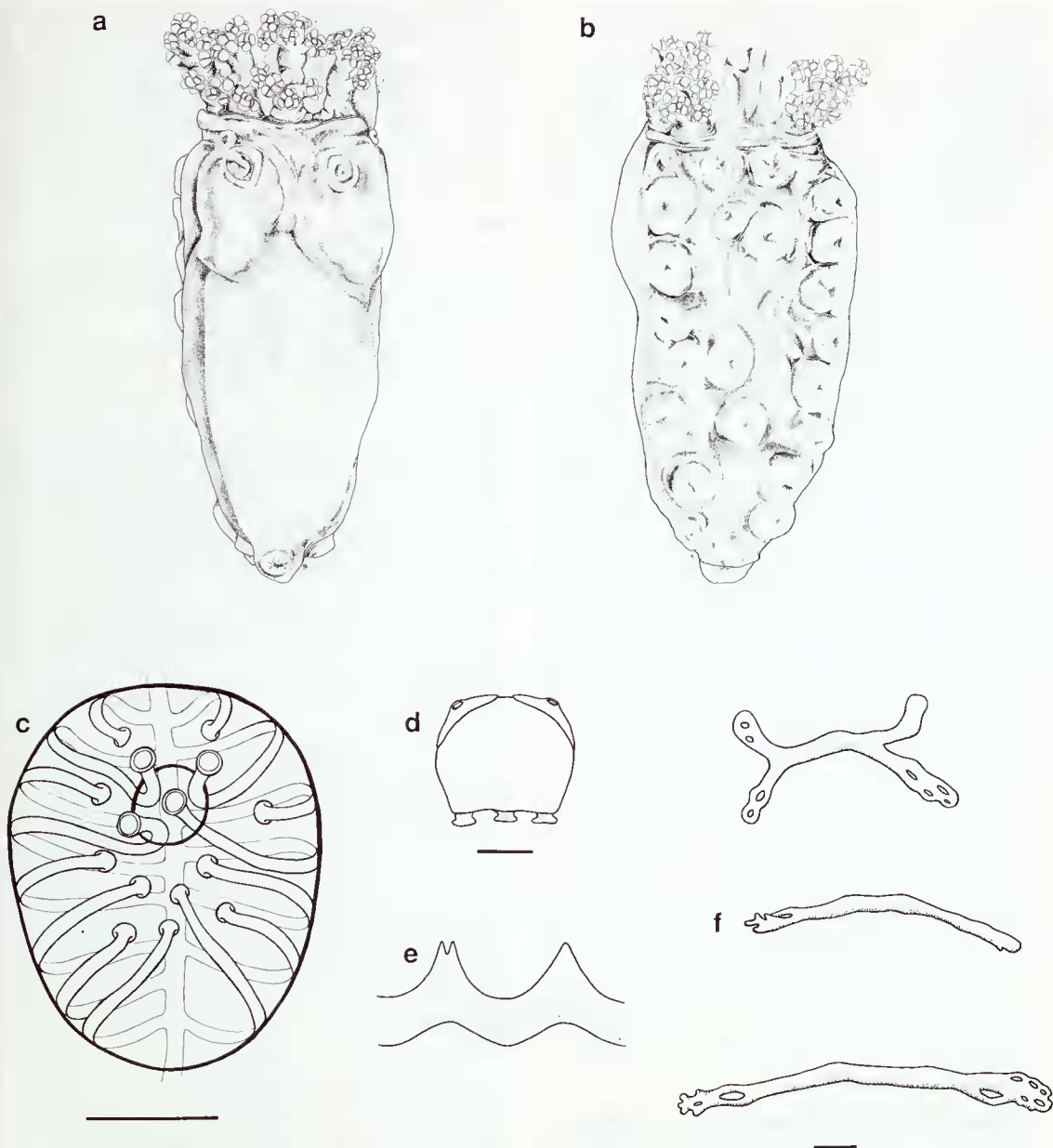


Figure 3. *Neocnus bimarsupius* sp. nov.: a, dorsal body view, showing paired anterior marsupia; b, ventral body view, showing extensible ventral tentacles; c, diagram of a marsupium, showing interior dorsal pedicels, with 4 extending through opening, scale bar = 0.5 mm; d, transverse section of body, scale bar = 1.0 mm; e, adjacent radial and interradial plates from the calcareous ring; f, tentacle rod ossicles, scale bar = 0.01 mm.

Tasmania, Lulworth, Black Rock Point, 22 Nov 1982, NMV F53787(15).

Description. Up to 6 mm long, 3 mm high, 2.5 mm wide; body roughly egg-shaped; tentacles orientated anteriorly or slightly upturned, anus posterodorsal; 2 dorsal brood pouches in anterior body wall except in juveniles, each with external round aperture, and small interior pedicels which may extend through the aperture; body wall thin, soft; 10 dendritic tentacles, 2 ventral ones small, slightly lobed, extensible to 3.0 mm long, with a pedicel-like attaching capability; distinct sole; introvert not distinct from body wall. Sole with peripheral row of up to 20 large pedicels, up to 4 anterior ones aligned transversely; up to 4 irregularly on midventral radius; not extending to introvert and anus; mostly no pedicels on lateral or dorsal surfaces, except some within the dorsal marsupia and frequently single small radial pedicels anteriorly, most prominent dorsolaterally; up to 5 small pedicels around anus. Calcareous ring lacking posterior prolongations; 10 plates with similar anterior tapered projections, posterior scallops; radials with small anterior notch. Madreporite dorsal; single polian vesicle left lateral; intestine ventral, with full loop extending coelom length, single additional short dorsal loop near anus.

Body wall mostly lacking ossicles, a few rods in dorsal, anal body wall; sole lacking ossicles. Pedicels lacking endplates or ossicles. Tentacles with abundant thin straight and curved rods, typically 0.08 mm long; ends of rods swollen, with 1–6 small holes or notches, divided end of rod often twisted together; rods rarely with side branches or forks. Ossicles similar in juveniles.

Live colour. Body dark to very dark grey or brown; sole, pedicels, tentacles to varying degrees lighter in colour; colour persists in alcohol.

Reproduction. All observed gonads contain eggs and are similar in form, suggesting hermaphroditic or pathenogenic reproduction. All adults (July to April) with similar mature gonads and brood juveniles; gonad dorsal, with up to 8 sac-like caeca, graded in size from bud to fully-developed; largest caeca lie against wall of brood pouch, each caecum with up to 13 large yellow eggs or embryos and a few small white eggs interspersed; large eggs or embryos frequently 0.6 mm long, up to 1.2 mm long; small caeca with up to 15 small white eggs. Short anterior dorsal gonoduct; gonopore between bases of dorsal tentacle pair. Two separate anterior dorsal brood

pouches sit radially within body wall, separated from coelom, exterior to dorsolateral radial muscle band; each pouch with central aperture; series of up to 16 very small pedicels within each pouch, may extend out of the pouch aperture. Each brood pouch with up to 14 embryos or juveniles, uniform in size, differentiation evident at 0.7 mm long; brood juveniles up to 1.5 mm long.

Etymology. From the Latin *bini* (two) and *marsupium* (pouch, ablative case), with reference to the two brood pouches.

Distribution. Robe, South Australia, to Cape Paterson, Victoria, and north-eastern Tasmania. 0–6 m.

Remarks. This species is similar to *N. incubans*. Both are small and epiphytic, brood their young in marsupia in the anterior dorsal body wall, and have tentacle rods as the main ossicle form. *N. incubans* differs in having small irregular perforated plates as well as rods in the tentacles, rods of a different shape, rods and small plates in some posterior pedicels, rare large smooth perforated plates in the body wall, and only one large marsupium which contains up to 30 eggs or embryos and juveniles.

In *N. bimarsupis* the method of transfer of eggs or embryos from the gonad to the marsupia is not known. With the extensible attaching ventral tentacles, and the small suckered pedicels extending through the marsupium opening, there is a capacity for transfer of eggs or embryos from gonopore to marsupium. Numbers of eggs in a mature gonad sac, and of brood juveniles in a marsupium, are similar. If there is a single action of transfer from one mature gonad sac to one marsupium, the action would be remarkably efficient. Since no brood juveniles with fully developed tentacles and mouth have been found in the marsupia, it appears that brood juveniles complete their development to a stage of independent nutrition outside the marsupium.

N. bimarsupis is found on algae, particularly brown algae, e.g. *Zonaria angustata* (Kuetz), in the rocky shallows, where it appears as a very small, dark, soft but tough, oval protuberance on the algal fronds. Its relatively large ventral pedicels enable it to cling strongly to its substrate.

Squamocnus gen. nov.

Diagnosis. 10 dendritic tentacles, ventral 2 smaller; 5 oral valves; pedicels on ventral radii and scattered on dorsal radii and interradii. Body wall ossicles cups, knobbed perforated but-

tons and large multi-layered ossicles; pedicels with perforated bar-like ossicles and endplates; tentacles with perforated bar-like ossicles, small mesh-like plates and rosettes. Calcareous ring simple, with undulating posterior margin and anterior tapers.

Type species. Squamocnus aureoruber sp. nov.

Etymology. From the Latin *squama* (scale) in reference to the multi-layered ossicles in the body wall, with *Ocnus* (masculine).

Remarks. Several existing cucumariid genera have similar ossicles. *Leptopentacta* H.L. Clark, 1938 differs in having short posterior "tails" on the radial plates in the calcareous ring and pedicels restricted to the radii. *Loisettea* Rowe and Pawson, 1985 has deep complex cups, elongate calcareous ring plates and (at least on the type species) large papillae on the radii. *Trachythyone* Studer, 1876 has a similar body form, but has smooth single-layered plates as the main ossicle form. *Ocnus* Forbes, 1841 has similar knobbed buttons and cups, but lacks multi-layered plates and the pedicels are restricted to the radii.

Several little-known forms, previously referred to *Ocnus* or *Trachythyone*, are possibly better placed in *Squamocnus*. *O. brevidentis* (Hutton, 1872), from New Zealand, is possibly congeneric. Unfortunately, there has been considerable variation in the descriptions of this species. Dendy (1896) and Panning (1949) found multi-layered ossicles, knobbed buttons, cups and scattered dorsal pedicels in their specimens. Mortensen (1925) described "large, smooth plates"; Pawson (1970) made no mention of large plates at all. Possibly more than one species is involved.

O. syracusanus (Grube, 1840) from Europe has pedicels distributed on both radii and inter-radii, reduced ventral tentacles, reduced cups, knobbed buttons and multi-layered ossicles with a pronounced denticulate end. It has been recently referred to *Pseudocnella* by Thandar, 1987, but the other species in that genus have 10 equal tentacles and pedicels restricted to the radii.

O. kerguelensis (Thecl, 1886) with scattered dorsal pedicels, reduced ventral tentacles, multi-layered ossicles, knobbed buttons and x-shaped ossicles, is possibly related. *Trachythyone amokurae* (Mortensen, 1925), from New Zealand, has cups, smooth and knobbed buttons and large multi-layered ossicles in the dorsal body wall. Some of these multi-layered ossicles are extended at one end into a "spine". Pedicels are biserially arranged on the radii with a few scattered on the mid-dorsal interradius.

O. farquhari (Mortensen, 1925) and *O. sacculus* Pawson, 1983, also from New Zealand, have similar ossicles to *Squamocnus*, but lack any pedicels on the dorsal surface and probably deserve their own genus as Pawson (1983) suggests.

We have not had the opportunity to examine these species so final placement cannot be determined with certainty.

Squamocnus aureoruber sp. nov.

Plates 1d, 4a-h, Figure 4

Trachythyone sp. — Rowe and Vail, 1982: 222 (part). — O'Loughlin, 1991: 223, fig. 1.

Material examined. Holotype. Victoria, Cape Paterson, just below low tide level, 18 Jan 1980, M.

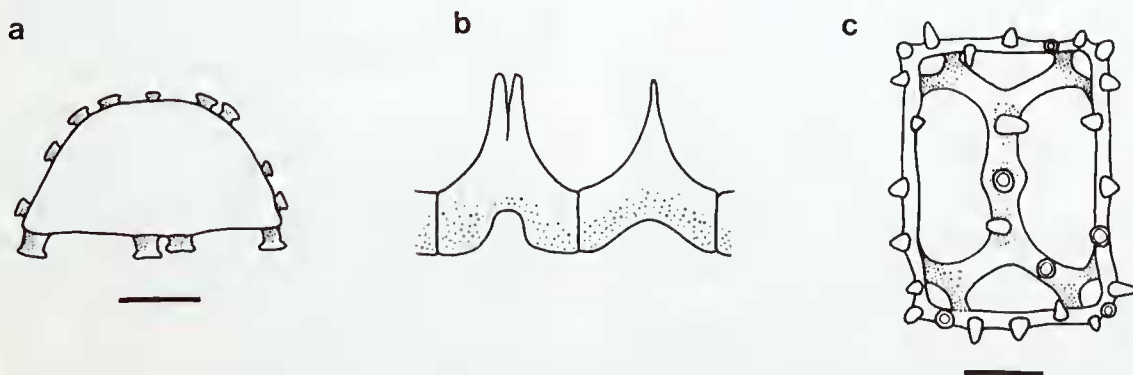


Figure 4. *Squamocnus aureoruber* gen. et sp. nov.: a, transverse section of body, scale bar = 1.0 mm; b, adjacent radial and interradian plates from the calcareous ring; c, top view of a dorsal body wall cup, scale bar = 0.01 mm.

O'Loughlin, T. O'Hara and J. Stephenson, NMV F54244.

Paratypes. Type locality and date, NMV F54243(69); NMV F58622(1*); Apollo Bay, Marengo. Hayley Point, just below low tide level, 11 Jan 1980. NMV F54242(11).

Other material (partial list; all found as algal epifauna, 0–2 m, unless otherwise stated; * indicates fissiparous specimens).

South Australia, Streaky Bay, Point Westall, 15 Jan 1991, NMV F59210(2); Robe, 10 Jan 1988, NMV F54703(4); NMV F58623(2*); 9 Jan 1990, NMV F57552(4*); Port MacDonnell, 8 Jan 1988, NMV F54705(13).

Victoria, Cape Otway, Crayfish Bay, 31 Dec 1980, NMV F53801(15); Marengo, 2 Jan 1990, NMV F57553(6*); 10 km NE of Apollo Bay, "Mullet Holes", 2 Jan 1988, NMV F54702(8); NMV F58626(1*); Lorne, Grey Point, 14 Jun 1982, NMV F53798(1); Bushrangers Bay, 28 Mar 1981, NMV F53804(1); Flinders, E of Mushroom Reef, 6 Mar 1982, NMV F53799(7); 13 Jul 1990, NMV F58631(1); 11 Aug 1990, NMV F58638(10*); NMV F58635(1); Shoreham, 18 Oct 1980, NMV F53796(3); NMV F58625(1*); Phillip I., Cowrie Beach, 27 Nov 1985, NMV F53802(11); NMV F58628(1*); Harmers Haven, 6 Mar 1982, CPA stn 23, NMV F53777(1); Cape Paterson, 14 Feb 1981, NMV F53803(18); NMV F58624(1*); 28 Apr 1989, NMV F54393(24); NMV F58627(1*); Inverloch, Eagles Nest, 4.5–7.6 m, 5 Mar 1982, CPA stn 3, NMV F53779(2).

Tasmania, Rocky Cape, 2 m, 15 Mar 1988, NMV F53765(1); Greens Beach, mouth of Tamar River, 7 Mar 1981, NMV F53790(2); Lulworth, Black Rock Point, 22 Nov 1982, NMV F53791(2 juv); Bichen, 7 m, 22 Mar 1988, NMV F59229(1).

Description. Up to 10 mm long (tentacles withdrawn), 1.7 mm high, 3 mm wide; body dome-like with slight dorsolateral angles in transverse section, flattened ventrally, rounded posteriorly, with extensible upturned anal cone; 10 dendritic tentacles orientated anteriorly, 2 ventral ones small; body wall thin, microscopically scaly; distinct flat, very thin-walled ventrum, not sole; very thin-walled introvert, lacking pedicels; 5 small radial oral valves which project partly over introvert; anus with 5 fine teeth. Ventral radii each with 2 irregular rows of pedicels, up to 40 in a row; pedicels large on mid-ventral and ventral rows of lateroventral radii; distinctly smaller on dorsal row of lateroventral radii, near anus and introvert; not extending onto introvert. Pedicels scattered dorsally, laterally, in irregular double rows on dorsal radii; single very extensible small pedicels on each anterior radial projection of body wall; 5 small extensible pedicels around anus. Calcareous ring lacking posterior prolongations; 5 radials with posterior notch, anterior taper and notch,

slightly higher than interradials; 5 interradials with posterior scallop, pointed anteriorly. Madreporite dorsal; single polian vesicle left lateral; intestine runs dorsally from mouth to mid-coelom, loops back to ring, then runs ventrally to anus.

Dorsal body wall ossicles of 5 types. 1) A surface layer of abundant small spinous cups, 2–3 times as wide as deep, typically 0.04 mm long; typically rectangular, with 4 large and 4 small corner holes; rim and cross thin, with short spines pointing mainly vertically out from cup. 2) Some shallow cups, slightly irregular, frequently 8-holed, only slightly spinous or lacking spines, 0.04–0.09 mm long. 3) Large, imbricating, knobbed, regularly perforated, often multi-layered ossicles, predominantly 2-layered, very irregularly oval, typically 0.3 mm long, up to 0.5 mm long. Knobs on developing plates join to create bars and secondary layers. 4) Knobbed and smooth buttons, frequently 4-holed, many fairly regular, typically 0.09 mm long. 5) Smooth, slightly convex, irregularly oval, perforated plates; holes large centrally, small peripherally; typically 0.1 mm wide. Ventral body wall with cups, buttons, convex plates, large plates with secondary developments but not multi-layered. Pedicels with endplates, 0.18 mm wide; flat and elongate to bar-like ossicles, frequently bent and curved and widened centrally and distally, perforated, irregular, up to 0.18 mm long. Tentacles with irregular, large to small, bar-like ossicles, some curved and bent and branched, perforated, up to 0.2 mm long; some irregular, convex, mesh-like, denticulate plates, 0.08 mm wide; rosettes, up to 0.05 mm long.

Live colour. Body, including ventral surface and pedicel walls, reddish orange often with slight dark flecking; ends of pedicels pale; tentacles yellow, with dark brown on trunks and introvert; all colour except dark markings lost rapidly in alcohol.

Reproduction. All observed gonads contain eggs and are similar in form, suggesting hermaphroditic or pathenogenic reproduction. The mature gonads have eggs or embryos in January (NMV F58626), February (NMV F53803), March (NMV F53799), July (NMV F58631) and August (NMV F58635). Gonad dorsal, up to 8 caeca graded in size, largest caeca with up to 15 yellow eggs or embryos interspersed with fewer small white eggs; eggs or embryos up to 0.7 mm long; short anterior dorsal gonoduct; gonopore between bases of dorsal tentacles.

Some specimens show evidence of fissiparity. Fission commences with a transverse growth change and constriction around the mid-body (NMV F54243). The constriction deepens and begins to separate the anterior and posterior halves (NMV F58623, F58624). The two ends finally separate by moving apart, as evidenced by the long connecting thread of body wall remaining in one specimen (NMV F58622). Matching and recently separated anterior and posterior ends have been found together (NMV F57553). Most large collections have one or a few with atypical round or short body form, and lack a calcareous ring and tentacles in some cases (NMV F57553) or the characteristic form of the posterior end in other cases (NMV F58623). One specimen is an posterior end with ring and tentacles at a very early development stage (NMV F58625).

Etymology. From the Latin *aureus* (golden) and *ruber* (red), in reference to the colour.

Distribution. Streaky Bay, South Australia. to Inverloch, Victoria, including northern Tasmania. 0–8 m.

Remarks. *S. aureoruber* can be distinguished from the similar species listed above in the generic remarks by the body wall ossicles, a combination of well-developed cups, rare knobbed buttons and oval multi-layered ossicles.

Evidence of fissiparity in *S. aureoruber* has been found throughout its geographical range, in small and large specimens, and in summer and winter. Direct observation of fission has not yet been undertaken. Preserved material provides strong evidence that fissiparity is a significant recruitment process. Mature gonads with eggs have been found in several specimens, indicating that recruitment is both sexual and asexual. Evisceration has not been observed, and this phenomenon would not provide an explanation for the absence of a calcareous ring and tentacles in some atypically short specimens.

Emson and Wilkie (1980: 161) noted that six holothurian species have been found to reproduce by fission, including two *Ocnus* species from the Cucumariidae. In *Ocnus planci* (Brandt, 1835) division usually occurs by twisting or stretching, muscles contract, and the pedicels pull in different directions until the tissues are severed.

Specimens have been found predominantly on algae in the rocky shallows.

Trachythyone Studer, 1876

Diagnosis (based on species currently assigned to the genus). 10 dendritic tentacles, ventral 2 usually smaller; pedicels on radii, sometimes also scattered on dorsal and lateral interradii. Body wall ossicles cups overlying numerous large perforated plates; plates usually smooth, rarely with some minor lumps, up to 0.95 mm long; often some knobbed buttons; cups small, shallow, sometimes spinous, sometimes replaced by rudimentary x-shaped ossicles. Tentacles and pedicels with perforated rods or plates; endplates present. Calcareous ring simple, without posterior prolongations. 10 plates, tapered anteriorly, posterior notches.

Type species. *Trachythyone muricata* Studer, 1876.

Remarks. The genus *Trachythyone* was revived by Panning, 1949 who assigned 21 species. He subsequently (1964) severely restricted the genus, referring (1966) many of the original species to *Leptopentacta* H.L. Clark, 1938. Panning (1964) suggested that one of the remaining species, *T. crucifera* (Semper, 1869), from the Indian Ocean, with its spiny cruciform plates, probably requires its own genus, *T. amokurae* (Mortensen, 1925) from New Zealand, with its multi-layered ossicles, is not a *Trachythyone* (see *Squamocnus* remarks).

What is left is predominantly a Southern Ocean genus with about ten species. Several need revision. For example, *T. parva* (Ludwig, 1874) was originally described as having x-shaped ossicles in the external skin layer. However, subsequent specimens with cups or flat "bowls" have also been referred to this species by Panning (1949, 1964), Hernandez (1982) and others. Various authors have also attempted to synonymize *Ocnus kerguelensis* (Theel, 1886), which has multi-layered ossicles, with *T. parva*. Clearly more than one species is involved. The species from Kerguelen, *T. muricata*, *T. squamata* (Ludwig, 1898), *T. parva*, *O. kerguelensis* and *O. ekmani* (Ludwig and Heding, 1935), need clear separation.

The generic diagnosis above has been broadened from that of Panning (1964) to include species with lumpy plates or with knobbed buttons. Several species have some minor lumps on the plates (e.g. *T. parva* sensu Panning, *T. macphersonae* Pawson, 1962a, *T. bouvetensis* (Ludwig and Heding, 1935)). However, the plates are never consistently knobbed to the extent of *Ocnus* or *Pseudocnus*. Several species (e.g. *T. bol-*

lonsi (Mortensen, 1925)) have knobbed buttons as a secondary ossicle type. As the primary ossicle type in these cases is smooth plates it seems unnecessary to exclude such species from *Trachythyone*.

The form of the ossicles is the main character distinguishing the species. *T. lechleri* (Lampert, 1885) stands a little apart from the others, having large plates with only very few tiny perforations and some incipiently multi-layered ossicles near the anus. Cups vary from predominantly x-shaped ossicles (e.g. *T. parva*, *T. bolousi*, *T. peruana* (Semper, 1868)), to well-developed cups with delicate cross and spinous rim (e.g. *T. squamata*, *T. muricata*), to shallow "bowl"-like cups with smaller perforations (e.g. *T. parva* sensu Panning, *T. macphersonae*, *T. mira* (Ludwig and Heding, 1935), *T. nina* (Deichmann, 1930)), to small irregular cups (e.g. *T. crassipeda* Cherbonnier, 1961, *T. bouvetensis*, *T. lechleri*).

The genus *Psolidiella* Mortensen, 1925 has plates, rudimentary cups and scattered dorsal pedicels. It can be distinguished from *Trachythyone* by the presence of a sole and the low incidence of ossicles in the body wall. The monotypic genus *Neopsolidium* Pawson, 1964, with type *N. convergens* (Herouard, 1901), is possibly a synonym of *Trachythyone* or *Psolidiella*. The main ossicle type is smooth, or lumpy, perforated plates, 0.2–0.4 mm long, overlain by small complete cups. The genus is currently placed in the Psolidae, but the form of the ossicles and the lack of a true sole indicates that the species is better placed in the Cucumariidae (Pawson, pers. comm.).

Trachythyone candida sp. nov.

Plates 1c, 5a–f, Figure 5a–c

Psolidium convergens. — Joshua, 1914: 6 [non *Neopsolidium convergens* (Herouard, 1901)].

Psolidium sp. — H.L. Clark, 1946: 415.

Trachythyone sp. — Rowe, 1982: 466, fig. 10.31c. — Rowe and Vail, 1982: 222 (part).

Material examined. Holotype, Victoria, Flinders, Jan 1912, coll. E.C. Joshua, NMV F59200.

Paratypes. Type locality and date, NMV F59201(1); MCZ 1151 (slide of whole body mount); Phillip I., Kitty Miller Bay, rocky shallows, just below low tide level, 8 Jan 1986, NMV F54229(1).

Other material (all found in the rocky shallows, 0–2 m, unless otherwise stated).

Victoria, Cape Otway, Moonlight Beach, 11–12 Mar 1975, NMV F57947(2); Deep Sea Cove, 20 Dec 1983, NMV F57945(1); Pebble Point, 18 Feb 1984, NMV F57950(1); Flinders, E of Mushroom Reef, 6 Mar

1982, NMV F54706(1); Harmers Haven, 18 May 1983, NMV F53784(1); Cape Paterson, 29 Mar 1982, NMV F54707(1); 25 Jan 1992, NMV F59228(4); Malacoota, buried in silt, rocky shallows, 21 Jan 1981, NMV F54701(1).

Tasmania, Bicheno, 7 m, 22 Mar 1988, NMV F59227(1); Eaglehawk Neck, 15 Feb 1991, NMV F59215(3); Tinderbox, below low tide level, 29 May 1974, AM J10863(1 and 5 slides); Southport, Sisters Bay, 8 May 1982, NMV F53792(1).

Description. Up to 8 mm long (tentacles partly extended), 3 mm wide; body predominantly round in transverse section to slightly pentagonal and keeled; body about twice as long as wide; mouth orientated anteriorly; extensible anal cone upturned; distinct modified ventrum, not a sole, rounded not flat; introvert distinct, thin-walled; 10 dendritic tentacles, 2 ventral ones small; body wall fairly thick, 0.4 mm, not rigid, microscopically scaly. Lacking oral valves, about 6 small anal teeth. Large pedicels on ventral radii, extend up to introvert and anus, distinctly smaller near introvert and anus; mid-ventral series an irregular zig-zag; ventrolateral radii with 2 rows, a ventral complete row and an outer lateral incomplete row; up to 35 pedicels on each radius. Small scattered pedicels dorsally and laterally, slightly concentrated on dorso-lateral radii into irregular zig-zag series; introvert lacking pedicels; 5 anterior thin extensible pedicels; about 6 extensible anal pedicels. Calcareous ring lacking posterior prolongations; 5 radials with posterior notch, anterior taper and notch; 5 interradials with posterior scallop, pointed anteriorly. Single polian vesicle, left lateral. Dorsal madreporite.

Dorsal body wall ossicles of 3 types: 1) Numerous large, thick, smooth plates, irregularly oval to elongate, up to 0.5 mm long, up to about 40 uniformly distributed perforations, some denticulate at one end with pointed spines, smaller perforations at opposite rounded end. 2) Some knobbed buttons, fairly regular, typically 4 holes, up to 8, typically 0.1 mm long. 3) Shallow cups, 4 times as wide as deep; typically 0.045 mm long; more commonly oval than rectangular; typically 4, up to 8, perforations; rim and cross thin with numerous peg-like spines pointing in all directions; cups form a surface layer in body wall. Ventral body wall with cups and elongate, narrow, slightly lumpy and knobbed, perforated plates, typically 0.25 mm long. Pedicels with endplates, up to 0.23 mm wide, and abundant, oval to elongate, curved, denticulate, often slightly lumpy, perforated plates, typically 0.2 mm long. Tentacles with irregular, curved

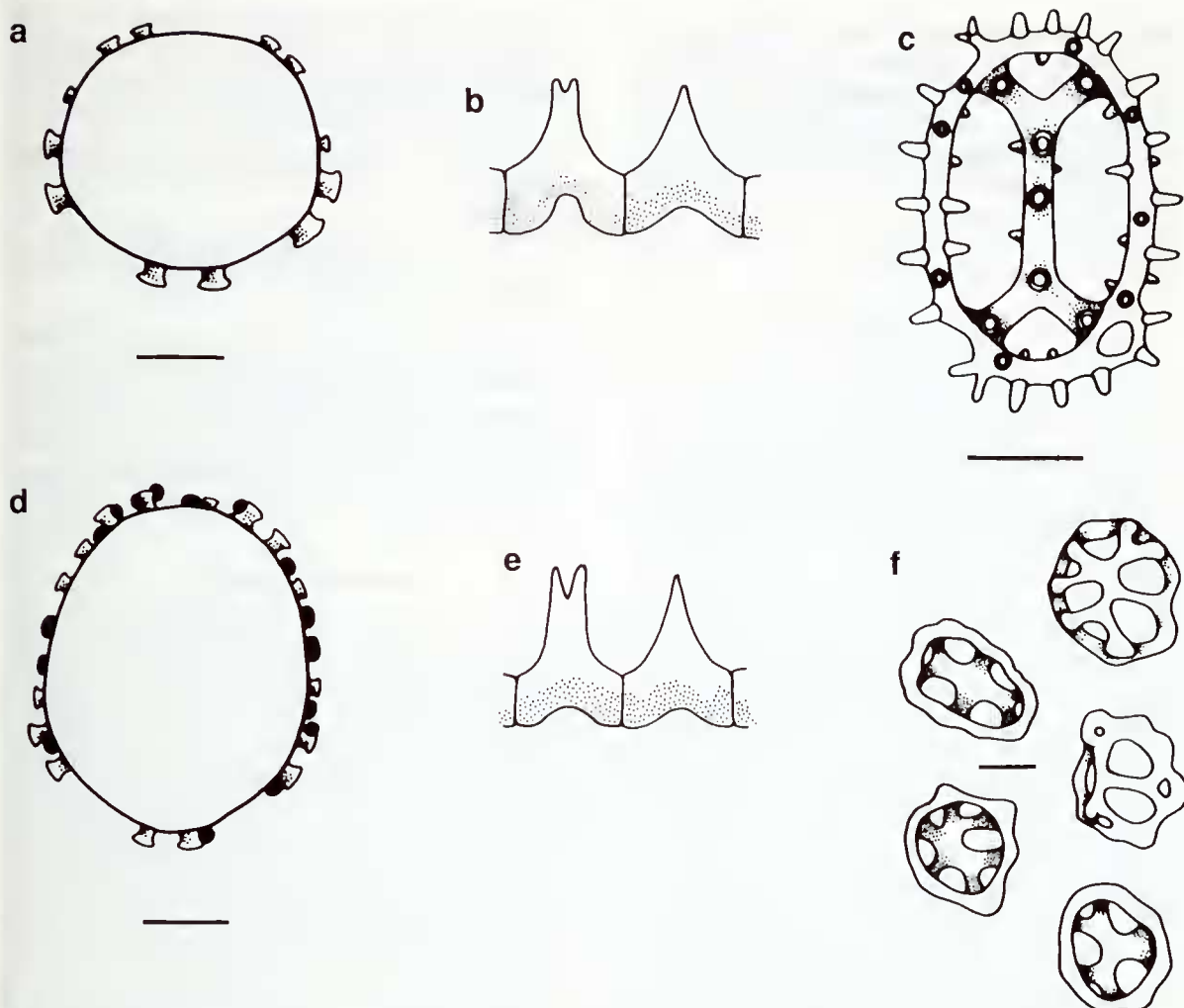


Figure 5. a–c, *Trachythyone candida* sp. nov.: a, transverse section of body, scale bar = 1.0 mm; b, adjacent radial and interradial plates from the calcareous ring; c, top view of a dorsal body wall cup, scale bar = 0.01 mm. d–f, *Trachythyone glebosa* sp. nov.: d, transverse section of body, scale bar = 1.0 mm; e, adjacent radial and interradial plates from the calcareous ring; f, dorsal body wall cups, scale bar = 0.01 mm.

and often bent, often widened centrally, perforated, bar-like ossicles, up to 0.25 mm long; and small, irregular, slightly convex, denticulate, closely perforated plates, typically 0.06 mm wide; lacking rosettes.

Live colour. Body uniform white or pale cream; crystalline; no dark markings; tentacles translucent, may be a few brown markings on trunks.

Reproduction. Sexes separate. Male or female gonad in most specimens (from December to May).

Etymology. From the Latin *candida* (glittering white), in reference to the colour.

Distribution. Western side of Cape Otway to Mallacoota, Victoria, and eastern Tasmania. 0–7 m.

Remarks. Joshua's (1914) specimens, which he identified as *Psolidium convergens*, have been re-examined by us and form the basis of this new species, *T. candida*. The specimens are still in excellent condition and, as the largest available, have been made the types. They do not belong to *Psolidium* Ludwig, 1886 as they do not have a true sole and do possess the medium-sized, non-imbricating, smooth plates in the body wall typical of *Trachythyone*. This species is similar to *Neopsolidium convergens* which, as indicated

above in the generic remarks, should probably be referred to *Trachythyone* or *Psolidiella*.

T. candida can be distinguished from *N. convergens* and all other *Trachythyone* species by the form of the cups, which typically have a complete rim and spines pointing in all directions on both cross and rim.

Specimens have usually been found in silt under rocks in the shallows.

***Trachythyone glebosa* sp. nov.**

Plates 1g, 5g-j, Figure 5d-f

Material examined. Holotype. South Australia, Kangaroo I., Vivonne Bay, N side of Point Ellen, rock and sand, 3-8 m, W. Zeidler and K.L. Gowlett-Holmes, 26 Jan 1989, SAM K1812.

Paratype. Western Australia, W end of Michaelmas I., 35°02.9'S, 118°01.4'E, 15 m, 17 Apr 1986, NMV F59226(1).

Description. Up to 12 mm long (tentacles extended), 3 mm wide and high. Body wall thin; body and pedicels with white lumps of massed ossicles, fewer ventrally; body rounded to slightly pentagonal in transverse section; distinct modified ventrum; mouth orientated anteriorly, anus posteriodorsally; 10 dendritic tentacles, 2 ventral ones distinctly smaller; distinct introvert, lacking pedicels; 5 small scale-like anal teeth; lacking oral valves. Pedicels large; irregular paired rows to zig-zag series on 5 radii; small scattered interradiial pedicels dorsally, laterally, lacking on ventral interradii. Pedicels small close to introvert and anus; 5 small ones around anus. Calcareous ring lacking posterior prolongations; 10 plates with tapered anterior projections, radially notched, posterior scallops. Single left lateroventral polian vesicle. Dorsal madreporite.

Dorsal body wall ossicles of 2 types. 1) Abundant large narrow plates, thick, smooth, perforated, rounded tapered ends, up to 0.6 mm long. 2) Cups small, irregular in shape, many with central cross and 4 holes, rim lumpy but lacking distinct knobs or spines, depth variable, most about 0.024 mm long, some larger rectangular ones about 0.04 mm long. Ventral body wall with cups, large narrow perforated plates up to 0.4 mm long. Pedicels with endplates, cups, curved narrow irregular perforated plates up to 0.25 mm long. Tentacles with many small to large, bent, perforated bar-like ossicles, up to 0.22 mm long; thin plates, irregularly oval, convex, denticulate, perforated, typically 0.056 mm wide; abundant rosettes, typically 0.04 mm long.

Colour (preserved). Body colour white to yellow; lumps on body wall and pedicels white; tentacle trunks dark. Dark brown flecking on all interradii of the W.A. specimen.

Reproduction. Immature gonad tubules present in the holotype.

Etymology. From the Latin *glebosa* (lumpy), in reference to the white lumps over the body and pedicels.

Distribution. Michaelmas I., Western Australia to Kangaroo I., South Australia. 3-15 m.

Remarks. Within *Trachythyone*, *T. glebosa* is distinguished by the massing of body wall ossicles into visible white lumps, the elongate shape of the smooth plates, and the very small irregular cups.

***Apsolidium* gen. nov.**

Diagnosis. Body stout with distinct sole and upturned anal and oral ends; 10 dendritic tentacles, ventral 2 smaller; pedicels on periphery and mid-ventral radius of sole, small ones scattered dorsally and laterally. Body wall ossicles knobbed cups, overlying numerous perforated, non-imbricating multi-layered ossicles, up to 1.1 mm long, and lumpy or smooth button-like ossicles. Tentacles with perforated plates, bar-like perforated ossicles; pedicels with perforated plates, endplates. Calcareous ring simple, without posterior prolongations, 10 plates, with tapered anterior projections and posterior scallops.

Type species. *Apsolidium handrecki* sp. nov.

Etymology. From the Latin *a* (from), in reference to the differences from *Psolidium* (neuter).

Remarks. *Apsolidium* is similar to the genus *Psolidium* Ludwig, 1886 from the family Psolidae. The psolids are characterized by the presence of a sharply defined sole on the ventral surface and an imbricating armour of large multi-layered ossicles, or scales, covering the dorsal surface. In *Psolidium* the dorsal scales are perforated by the scattered dorsal pedicels. The three species of *Apsolidium* on the other hand have smaller non-imbricating multi-layered ossicles, similar to other cucumariid species such as the *Cucuvitrum* and *Squamocnus* species described in this paper.

Several other cucumariid genera also have well-defined soles. Of these, *Pseudopsolus* Ludwig, 1898, *Neocnus* Cherbonnier, 1972 and *Microchoerus* Gutt, 1990 have reduced ossicles

and virtually no dorsal pedicels. *Psolidiella* Mortensen, 1925 has scattered small plates and rudimentary x-shaped cups. *Neopsolidium* Pawson, 1964, here also regarded as a cucumariid (see *Trachythyone* remarks), differs from *Apsolidium* in having single-layered, often smooth, dorsal plates.

***Apsolidium handrecki* sp. nov.**

Plates 2a, 6a–i, Figure 6a–d

Material examined. Holotype, Victoria, Merriicks, rocky shallows, 27 May 1989, M. O'Loughlin, T O'Hara and C. Matera, NMV F54391.

Paratypes. Type locality and date, NMV F54392(1 and 1 juv); 28 Jan 1983, NMV F53765(1); 29 Oct 1980, NMV F53763(2).

Other material. South Australia, Eyre Peninsula, Arno Bay, jetty piles, 2–3 m, 22 Feb 1988, SAM K1815(2).

Western Australia, Trigg I., off *Caulerpa*, 22 Nov 1969, NMV F59225(2).

Description. Up to 20 mm long (tentacles extended), 7 mm wide, 6 mm high; body stout with oral extension and upturned anal cone; body wall thin, densely crystalline; 10 dendritic tentacles, 2 ventral ones distinctly smaller; distinct oval sole, wider than body, margin upturned; distinct narrow introvert, lacking pedicels; anus with 5 teeth. Up to 5 rows of pedicels on periphery of sole, none extending beyond sole to introvert or anus, 2 rows on midventral radius, ventral interradii lacking pedicels; close cover of small pedicels dorsally, laterally, on oral extension and anal cone, used for attaching grit; very extensible small radial pedicels around mouth and anus. Calcareous ring lacking posterior prolongations; 5 radials with anterior projections, sometimes deeply divided, notched posteriorly; 5 interradians with pointed anterior projections, posterior scallops. Madreporite dorsal; single polian vesicle left ventral.

Dorsal body surface ossicles of 4 types. 1) Numerous multi-layered ossicles, non-imbricating, irregularly oval to elongate, up to 0.4 mm long, comprising regularly perforated thick knobbed plates linked together. 2) Some knobbed perforated plates developing secondary layers. 3) Some button-like ossicles, lumpy to smooth, thick, irregular, up to 8 holes, up to 0.2 mm long. 4) A surface layer of fine-rimmed deep cups, typically oval, 4 holes, about as deep as wide; arms of cross thin, branched, terminally knobbed, ends joined to varying degrees to form thin, finely knobbed, sometimes incomplete rim; commonly 0.06 mm long. Sole with cups; abundant elongate plates, frequently narrow,

irregular, thick, smooth to knobbed, some bent, up to 15 holes, up to 0.2 mm long; button-like ossicles, fairly regular, typically 4-holed, typically 0.1 mm long; lacking multi-layered ossicles and plates with secondary developments. Pedicels with endplates, 0.24 mm wide; cups; irregular narrow perforated plates, some finely knobbed, bent, curved, convex, up to 0.14 mm long. Tentacles with abundant rosettes, up to 0.08 mm long; bar-like ossicles, small to large, straight or bent, perforated, some widened centrally, up to 0.27 mm long; fine mesh-like plates, irregularly oval to rectangular, convex, denticulate, up to 0.08 mm long.

Live colour. Body grey, created by dense brown-black flecking dorsally; sole pale grey with sparse flecking interradially; rim of sole cream; anal cone dark at apex; tentacle trunks, introvert, oral disc dark brown; tentacle branches pale yellow.

Reproduction. Sexes separate. Holotype and larger paratype (NMV F54392) with mature female gonads; paratype (NMV F53765) with mature male gonad; juvenile (NMV F54392, 5 mm long) with gonad development beginning. Gonoduct attached to dorsal body wall; gonopore between bases of dorsal tentacles.

Etymology. Named in recognition of the contribution by Mr Clarrie Handreck to the fieldwork of the Marine Research Group of Victoria and to the collection of this species.

Distribution. Merriicks, Victoria, to Trigg I., SW Western Australia. 0–3 m.

Remarks. At Merriicks, Western Port, this species is found adhering to the top or side of rocks in shallow water.

***Apsolidium densum* sp. nov.**

Plates 2b, 7a–h, Figure 6e–g

Material examined. Holotype, Victoria, 10 km NE of Apollo Bay, "Mullet Holes", under rock just below low tide level, 11 Jan 1984, M. O'Loughlin, NMV F54237.

Paratypes. Type locality and date, AM J22753(1); type locality, 7 Jan 1985, NMV F53764(1); Victoria, Flinders, Mushroom Reef, rocky shallows, 22 Jan 1982, NMV F53766(1).

Description. Largest 40 mm long (tentacles withdrawn), 18 mm wide, 12 mm high (mid-body); smaller specimens more elongate; body stout with oral extension and anal cone upturned; body wall thick, up to 1.5 mm, densely crystalline; 10 dendritic tentacles, 2 ventral ones distinctly smaller; distinct oval sole, narrower than

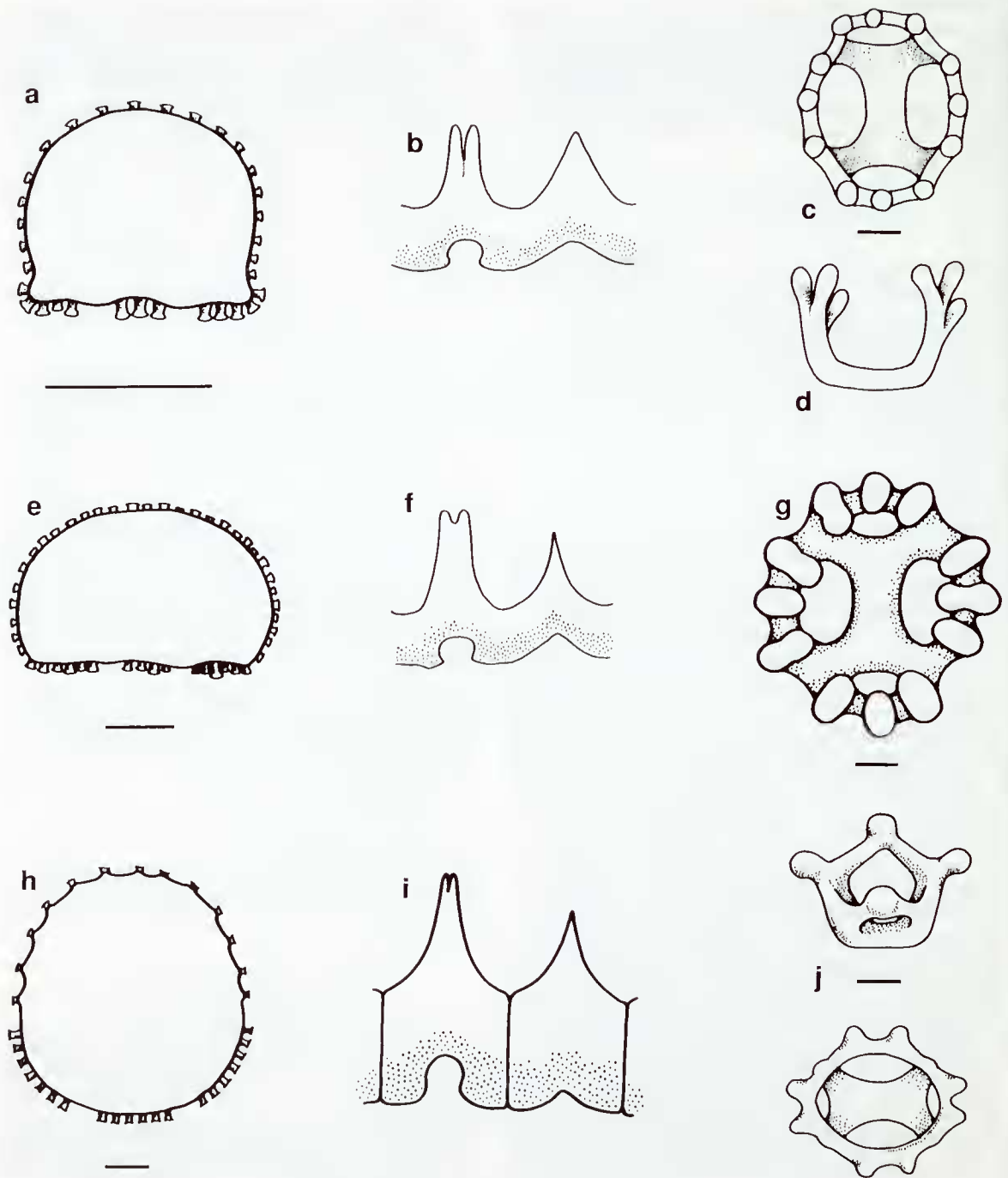


Figure 6. a–d, *Apsolidium handrecki* gen. et sp. nov.: a, transverse section of body, scale bar = 5.0 mm; b, adjacent radial and interradial plates from the calcareous ring; c, top view of a dorsal body wall cup; d, side view of an incomplete cup, scale bar = 0.01 mm.

e–g, *Apsolidium densum* sp. nov.: e, transverse section of body, scale bar = 5.0 mm; f, adjacent radial and interradial plates from the calcareous ring; g, top view of a dorsal body wall cup, scale bar = 0.01 mm.

h–j, *Apsolidium alvei* sp. nov.: h, transverse section of body, scale bar = 5.0 mm; i, adjacent radial and interradial plates from the calcareous ring; j, side and top views of dorsal body wall cups, scale bar = 0.01 mm.

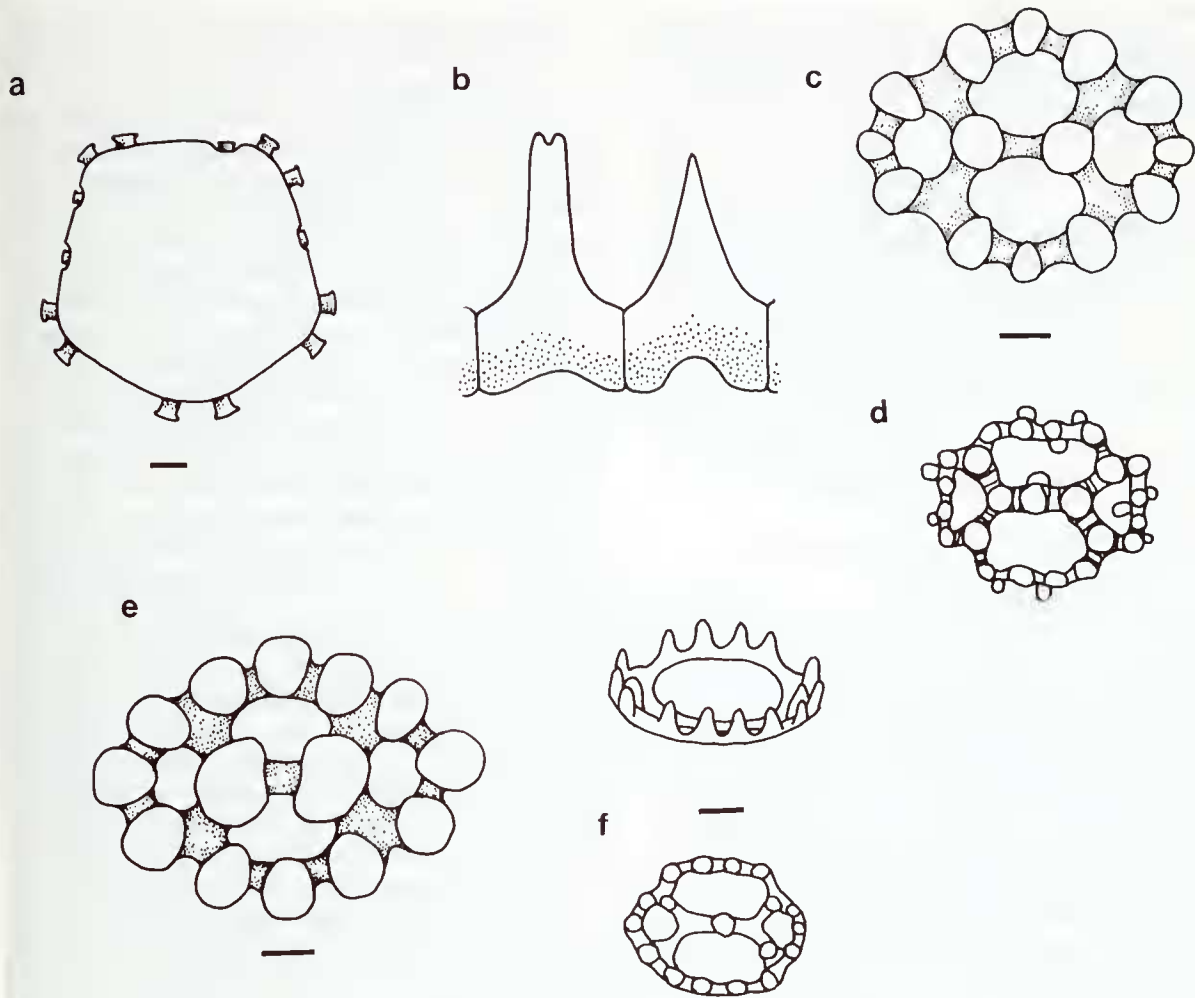


Figure 7. a–d, *Ocnus occidentus* sp. nov.: a, transverse section of body, scale bar = 1.0 mm; b, adjacent radial and interradial plates from the calcareous ring; c, dorsal body wall button; d, top view of a dorsal body wall cup, scale bar = 0.01 mm.

e–f, *Ocnus calcareus* (Dendy, 1896): e, dorsal body wall button; f, side and top views of dorsal body wall cups, scale bar = 0.01 mm.

body. Up to 6 rows of pedicels on periphery of sole, none extending beyond sole to introvert or anus, up to 4 rows on midventral radius, ventral interradii lacking pedicels; close cover of small pedicels dorsally, laterally, on oral body extension and anal cone, used for attaching grit. Calcareous ring lacking posterior prolongations; 5 radials with notched anterior projections, notched posteriorly; 5 interradials, with slightly lower pointed anterior projections, posterior scallops. Single polian vesicle left ventral. Dorsal madreporite.

Dorsal body wall ossicles of 5 types. 1) Massed multi-layered ossicles, irregular, up to 1.1 mm long, comprising regularly perforated thick

knobbed plates linked together. 2) Knobbed perforated thick plates with extending knobs, connecting bars, developing secondary layers. 3) Some button-like ossicles, lumpy or smooth, fairly regular, often 4-holed, commonly 0.14 mm long. 4) Some smooth, regularly perforated, somewhat denticulate plates, 0.18 mm long. 5) Knobbed cups, typically oval with 4 holes, rim rarely continuous at corners, about twice as wide as deep, cross and rim thick, only rim heavily knobbed, commonly 0.08 mm long. One large knobbed cup, 0.2 mm long. Solc with cups, smaller multi-layered ossicles. Pedicels with endplates, 0.18 mm wide; cups; bar-like ossicles, thick, straight to bent, sometimes curved, per-

forated, up to 0.34 mm long; perforated plates, irregularly triangular to elongate, marginally denticulate or slightly knobbed, straight or bent, sometimes curved, 0.2 mm long. Tentacles with abundant bar-like ossicles, large to small, irregular, thick, bent, curved, some widened centrally, perforated, up to 0.38 mm long; perforated plates, flat to curved, irregular, up to 0.24 mm long; abundant mesh-like plates, irregularly oval to triangular, convex, denticulate, typically 0.08 mm wide; rosettes up to 0.12 mm long.

Live colour. Body white; some grey flecking dorsally and on oral extension.

Reproduction. Sexes separate. NMV F53766 with male gonad; holotype with female gonad and small eggs.

Etymology. From the Latin *densum* (thick), in reference to the body wall.

Distribution. Apollo Bay and Flinders, Victoria. 0–1 m.

Remarks. *A. densum* differs from *A. handrecki* in having a very thick body wall; a sole that is narrower than the width of the body; larger ossicles in the body-wall, pedicels and tentacles; more knobs and other secondary developments on plates in the sole; larger, shallower, heavily knobbed cups; and white colour.

Despite intensive searching in the rocky shallows, this species has been found at only two open ocean localities: near Apollo Bay and Flinders, Victoria.

Apsolidium alvei sp. nov.

Plates 1f, 8a–f, Figure 6h–j

Cucumaria squamata. — Joshua and Creed, 1915: 17. [non *Trachythyone squamata* (Ludwig, 1898)].

Cucumaria squamatoidea H.L. Clark, 1946: 389. — A.M. Clark, 1966: 345.

'Cucumaria' squamatoidea. — Rowe, 1982: 466, fig. 10.31b.

Material examined. Holotype. South Australia, Yorke Peninsula, Marion Bay, washed up on beach, 6 Sep 1978, W Zeidler, SAM K1824.

Paratypes. Type locality and date, SAM K1825(2).

Other material. South Australia, Yorke Peninsula, Marion Bay, in *Posidonia* bed exposed at low tide, 28 Jan 1979, SAM K1821(1); Adelaide, between North Haven and Largs Jetty, 300 m offshore, seagrass, 1 Dec 1980, SAM K1823(1); Glenelg, 10 m, 15 Feb 1959, in *Posidonia*, AM J22638(1); Port Noarlunga, 1960, SAM K1822(1); Encounter Bay, coll. Dr Verco, identified as *Cucumaria squamata* by Joshua and Creed, 1915, SAM K1369(1).

Description. Largest 52 mm long, 33 mm high, 27 mm wide (tentacles slightly extended); body fat, rounded, slightly convex dorsally, deeply convex ventrally; short anteriodorsal and posteriodorsal oral and anal cones; body wall tough, flexible; 10 dendritic tentacles, 2 ventral ones distinctly smaller; distinct short convex sole-like modified ventrum; distinct introvert, lacking pedicels. Lacking oral valves. Ventral radii with 3 short parallel series of small pedicels, widely separated from introvert and anus, about 5 irregular rows on ventrolateral radii, up to 4 rows on midventral radius; small pedicels scattered sparsely and evenly over body, not on introvert or interradii of ventrum. Calcareous ring lacking posterior prolongations; 5 radials with posterior scallop, anterior taper and notch; 5 interradians with posterior scallops, pointed anteriorly. Single elongate polian vesicle, left lateral.

Dorsal body wall ossicles of 3 types. 1) Abundant large plates, thick, smooth, very irregularly oval, closely perforated, often with developing secondary layers and thickenings, up to 1.1 mm long. 2) Button-like ossicles thick, smooth, irregularly quadrilobed to elongate, with up to 8 perforations, typically 0.1 mm long. 3) Deep cups, round to oval, rim knobbed, cruciform centrepiece broad and smooth, 4-holed, some as deep as long, typically 0.045 mm long. Ventral body wall with cups; narrow plates, thin to thick, sometimes lumpy, irregular, up to 14 perforations, typically 0.24 mm long; lacking large plates. Pedicels with endplates, 0.4 mm wide; typical cups; irregular thin, narrow, perforated plates, some curved or bent, some widened centrally, typically 0.24 mm long. Tentacles with small to large, bar-like ossicles, somewhat flat, perforated, often bent with outer widening centrally, up to 0.36 mm long; typical cups; rosettes rare.

Colour (preserved). Body white or pink, very dark orally and anally; tentacle trunks very dark.

Reproduction. Sexes separate; mature gonads present in September; gonopore at inner base of dorsal tentacle pair.

Etymology. From the Latin *alveus* (belly of a ship), in reference to the body form.

Distribution. Yorke Peninsula to Encounter Bay, South Australia. 0–10 m.

Remarks. *A. alvei* is referred to *Apsolidium*, and not *Trachythyone*, on the basis of the form of the

body wall ossicles and the distribution of pedicels. The body wall plates consistently develop secondary layers and the cups are deep with a knobbed rim, similar to *A. handrecki*. The pedicels are arranged in up to five rows on the ventral radii, and reduced and scattered dorsally, without any signs of concentration on the laterodorsal radii. On the other hand, the secondary developments on the body wall plates are not developed to the extent of *A. handrecki* or *A. densum*. The body form, including the small sole-like ventrum, is also very different from the two other *Apsolidium* species. This correlates with the known habitat of the three species: *A. alvei* prefers seagrass beds while *A. handrecki* and *A. densum* live on rocks. The authors are not satisfied that enough evidence currently exists to assign *A. alvei* its own genus.

The specimen, identified by Joshua and Creed (1915) as *Cucumaria squamata*, has been re-examined by the authors and referred to this species. H.L. Clark (1946) proposed the replacement name *C. squamatoides* for this specimen. However, it was never adequately described by Joshua and Creed, nor examined by H.L. Clark. The name *squamatooides* is therefore a nomen nudum, failing to satisfy ICZN Article 13 as pointed out by A.M. Clark (1966: 345).

A. alvei has been taken predominantly from seagrass (*Posidonia*) beds in Gulf St Vincent.

Ocnus Forbes, 1841

Diagnosis (based on Panning, 1971). Body cucumber-shaped, slightly angular; 10 dendritic tentacles, ventral 2 smaller; pedicels in 1–2 rows on radii. Body wall ossicles cups and small knobbed perforated plates, often with 4 primary holes; pedicels with perforated plates and endplates. Calcareous ring with posterior notches and long tapers anteriorly.

Type species. *Ocnus plani* (Brandt, 1835).

Remarks. *Ocnus* has traditionally been a large and heterogeneous taxon. Panning (1971) restricted it to only 5 species: *O. plani* (with synonym *O. brunneus* Forbes, 1841) and *O. lacteus* Forbes, 1841 from Europe; and with some doubt: *O. spyridophora* H.L. Clark, 1925 from Hawaii, *O. vicarius* Bell, 1883 and *O. calcareus* (Dendy, 1896) from New Zealand. Unfortunately he did not assign other species, previously referred to *Ocnus*, to other genera. Meanwhile Rowe (1970) established *Ashia* for species with knobbed buttons with four holes only. This distinction is a little arbitrary as buttons with four holes and buttons with more than four holes

often occur in the same animal. We believe that it is appropriate to separate species which have multi-layered ossicles. Some of these species have been discussed under *Squamocnus* gen. nov.

Within Panning's (1971) *Ocnus* species, *O. calcareus* (and the following new species) differ somewhat from the European species. *O. calcareus* has cups based on a cruciform piece, rather than the three-rayed base of the cups in *O. plani* and *O. lacteus*; and also has some additional large flat plates in the body wall. A future revision could separate the two groups into different genera.

Ocnus occiduus sp. nov.

Plates 1h, 9a–f, Figure 7a–d

Ocnus calcareus. — Rowe, 1982: 446, fig. 10:32a [non *Ocnus calcareus* (Dendy, 1896)].

Material examined. Holotype. South Australia, Ceduna, Cape Vivonne, under rocks, 0–1 m, 14 Jan 1991. M. O'Loughlin, NMV F59212.

Paratypes. Type locality and date, NMV F59213(6).

Other material. Western Australia, Rottnest I., North Point, rocky reef, 30 m, 11 Jan 1991, WAM 254-91(1); Cape Naturaliste, Eagle Bay, Apr 1964, WAM 766-71(1); Bunker Bay, 29 Jan 1975, WAM 425-78(1); Cowaramup Bay, 21 Oct 1989, WAM 880-89(1); Flinders Peninsula, Salmon Holes, 20 Jan 1988, WAM 161-88(1).

South Australia, Nuyts Archipelago, St Francis I., 24 Jan 1982, SAM K1811(9); Franklin Is, 24 Feb 1983, SAM K1810(2); Streaky Bay, Point Westall, 15 Jan 1991, NMV F59219(1); Yorke Peninsula, Gleasons Landing, 8 Nov 1976, SAM K1816(1).

Description. Largest 32 mm long, 10 mm wide, 6 mm high (tentacles withdrawn); body short, wide, low, to elongate or thin, slightly pentagonal in transverse section, frequently twisted; body wall thick, finely crystalline, soft and flexible; mouth orientated anteriorly, anus posteriorly; 10 dendritic tentacles, 2 ventral ones distinctly smaller; distinct thin-walled modified ventrum; distinct introvert, lacking pedicels. Pedicels in paired rows on 5 radii, more regular and distinct ventrally creating distinct modified ventrum; a few small dorsal and lateral inter-radial pedicels; small pits created where pedicels withdraw into body wall. Calcareous ring lacking posterior prolongations; 5 radials, with posterior scallops, tapered notched anterior projections; 5 interradials, with posterior scallops, pointed anterior projections. Dorsal madreporite. Single polian vesicle, left lateroventral.

Dorsal body wall ossicles of 4 types. 1) Masses of knobbed buttons, fairly regular, typically 4-holed, oval, flat, knobbed centrally and peripherally; typically 14 knobs, 2 central ones not normally larger than peripheral ones, mid-lateral and mid-terminal knobs often smaller than central ones or absent; largest buttons typically 0.09 mm long. 2) Perforated bar-like ossicles, thick, frequently bent or curved, up to 0.29 mm long. 3) Rare large plates, irregularly oval, smooth to lumpy, regular rounded perforations, up to 0.4 mm long. 4) Abundant cups, fairly regular, shallow, about 4 times as long as deep; frequently oval and 4-holed, some rectangular and up to 8-holed; capitate to peg-like spinelets centrally, peripherally, mostly pointing in all directions; cups typically 0.04 mm long. Ventral body wall ossicles as dorsally, but lacking large plates. Pedicels with endplates, 0.22 mm wide; bar-like ossicles, curved or bent, widened centrally, perforated, up to 0.26 mm long; convex, irregular, denticulate, perforated plates, 0.11 mm long. Tentacles with small to large bar-like ossicles, straight and bent, some widened centrally, perforated, up to 0.4 mm long; convex mesh-like plates, irregularly oval to triangular, denticulate, typically 0.06 mm wide; rosettes, 0.07 mm long; some irregular, smooth, slightly convex, perforated plates, 0.11 mm long.

Live colour. Body uniform white, grey on thin ventral surface and sometimes laterally; tentacle trunks dark brown to black; fine tentacle branches pale yellow.

Reproduction. Sexes separate; mature gonads present January and October; gonoduct right dorsolateral; gonad tubules not forked.

Etymology. From the Latin *occiduus* (western), in reference to the western occurrence of this species in southern Australia.

Distribution. Rottnest I., Western Australia to Yorke Peninsula, South Australia, 0–30 m.

Remarks. Three small specimens of *Ocnus calcareus* from New Zealand (AM G1762) were examined for comparison. They conform to the descriptions and figures given by Dendy (1896) and Mortensen (1925). They differ consistently from the Australian species. The largest buttons have two central knobs which are normally significantly larger than the 12 uniform peripheral ones (fig. 7c). The cups are slightly smaller, typically 0.03 mm long; normally four-holed; typically with spinelets pointing vertically to the

plane of the cup rim (fig. 7f). The dorsal body wall contains similar bar-like ossicles to *O. occiduus*. The tentacle ossicles are unfortunately extensively eroded, but no rosettes were observed. The body form is more distinctly pentagonal anteriorly. The pedicels emerge from body wall tubercles, and in no instances are withdrawn into pits. These differences are slight, but in the opinion of the authors, significant enough to recognize a new taxon.

O. occiduus is usually found under rocks in the shallows. Despite intensive searching, this species has not been found east of Yorke Peninsula, South Australia.

Thyonidiinae Heding and Panning, 1954

Neocucumis Deichmann, 1944

Diagnosis (based on species currently assigned to the genus). 20 dendritic tentacles, usually in 2 rings, 5 pairs of large interradiial tentacles, 5 pairs of small radial tentacles; pedicels in double rows on radii; ossicles tables with round or irregular perforated discs (0.05–0.45 mm diameter) and 2-pillared spires with terminal thorns; pedicel ossicles tables with elongate narrow discs and low 2-pillared spires, endplates, rarely rods, rosettes; calcareous ring simple, without posterior prolongations, 10 plates, radials irregularly rectangular with a large posterior notch and 1–3 smaller anterior notches, interradials at least 0.7 times as high as radials with a median posterior notch and sharp anterior point.

Type species. *Cucumaria marioni* Von Marenzeller, 1877.

Neocucumis cauda sp. nov.

Plates 2c, 10a–f, Figure 8a–d

Material examined. Holotype, Victoria, 19 km S of Lakes Entrance, 38°04'S, 148°00'E, 28 m, fine sand/shell substrate, 12 Aug 1989, G. Parry on FRV "Sarda", NMV F57952.

Paratype. Type locality and date, NMV F57953(1).

Other material. New South Wales, off Cape Three Points, 76–93 m, "Thetis", Feb 1898, AM J16358(4).

Description. Holotype 12 mm long (tentacles fully withdrawn), 4 mm wide, tail 4 mm long; paratype 9 mm long (tentacles fully withdrawn), 3.5 mm wide, tail 2 mm long; body wall thin; body round in transverse section, with long thin posterior tail; 20 dendritic tentacles, 5 outer pairs large, 5 inner pairs very small; lacking ring of papillae around tentacles. Pedicels in 2 rows

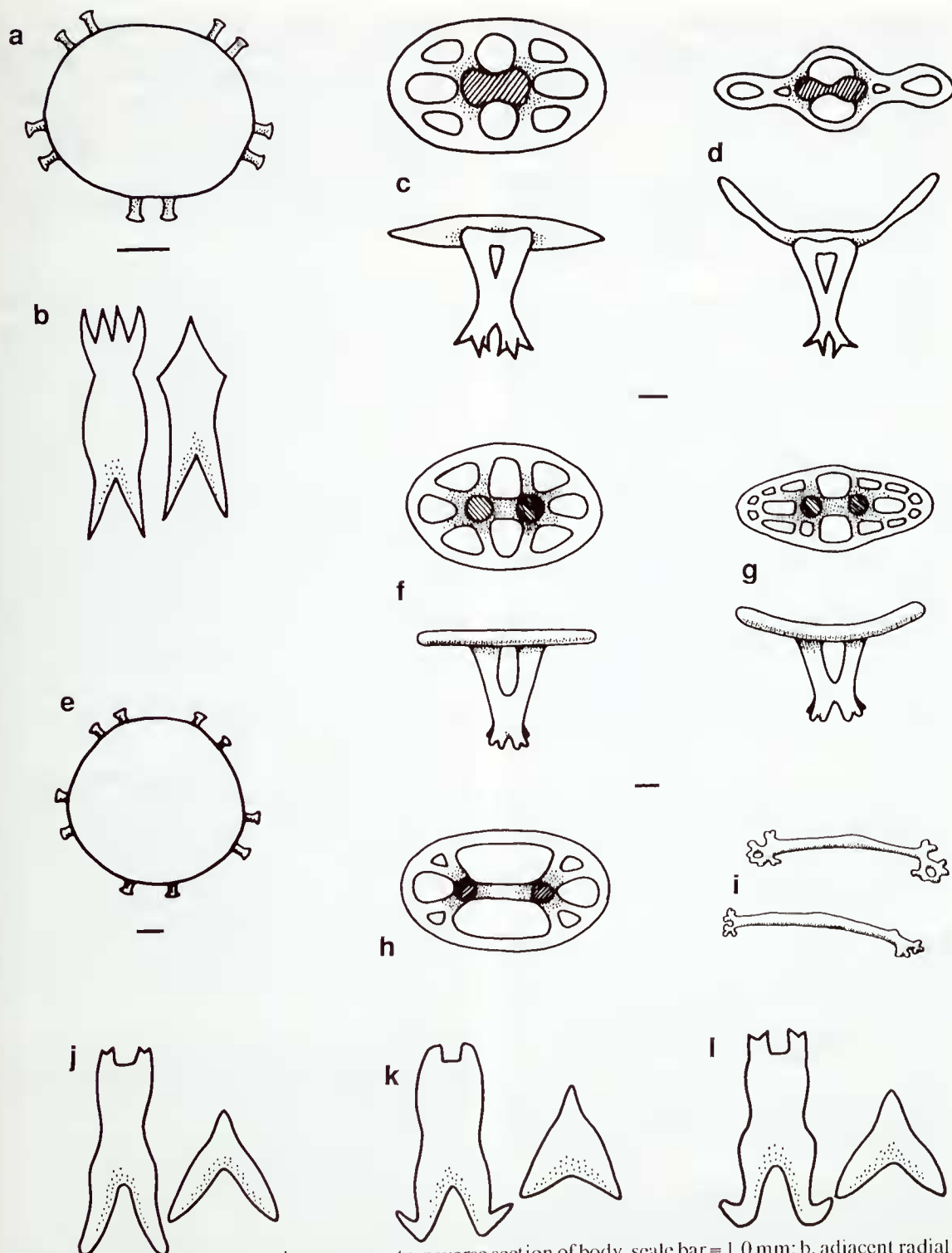


Figure 8. a–d, *Neocucumis cauda* sp. nov.: a, transverse section of body, scale bar = 1.0 mm; b, adjacent radial and interradial plates from the calcarous ring; c, top and side view of dorsal body wall table; d, top and side view of a pedicel table, scale bar = 0.01 mm.

e–l, *Neocucumella fracta* sp. nov.: e, transverse section of body, scale bar = 1.0 mm; f, top and side view of a dorsal body wall table; g, top and side view of a pedicel table; h, top view of an introvert table; i, tentacle rods, scale bar = 0.01 mm; j–l, adjacent radial and interradial plates of the calcarous ring in 3 specimens: j, SAM K1802; k, SAM K1796; l, SAM K1817.

on all 5 radii, up to 80 pedicels on each radius; pedicels slightly more developed ventrally; interrarial areas and introvert lacking pedicels; 5 pedicels around anus. Calcareous ring plates slightly separate; 5 radial plates with 4 pointed anterior projections, narrow angular waist, 2 pointed posterior projections; 5 interrarial plates with single pointed anterior projection, widened angular shoulders, 2 pointed posterior projections. Dorsal madreporite. Single left lateral polian vesicle.

Body wall ossicles of one type. Abundant closely situated tables; discs rectangular to oval, frequently very irregular, typically 0.09 mm long, typically with 4 large and 4 smaller corner holes, rarely up to 16 holes; spires v-shaped, 2 pillars fused distally, up to 0.04 mm high, typically 4 pairs of pointed terminal spines. Introvert with sparse, narrowly oval, irregular tables, up to 12 holes, up to 0.08 mm long. Pedicels with endplates, 0.13 mm wide; tables with curved discs, frequently very irregular, many very narrow, widened in centre, rounded at ends, up to 0.09 mm long, typically with 4 central holes and small terminal holes, spires similar to body wall tables, shorter, up to 0.03 mm high. Tentacles with numerous thin-walled, elongate, curved plates, up to 0.18 mm long, perforations elongate; numerous very irregular mesh-like plates, partly denticulate, typically 0.06 mm wide.

Reproduction. Holotype and paratype with dorsal female gonad; gonad tubules filled with eggs; up to 10 large tubules, 5 small; tubules elongate, each with a single fork mid-length. Gonoduct on right dorsal body wall.

Colour (preserved). Uniform cream; tentacles yellowish-green; tentacle trunks with transverse reddish-brown markings.

Etymology. From the Latin *cauda* (tail), with reference to the long, thin posterior end of the body.

Distribution. Bass Strait, south of Lakes Entrance, to Cape Three Points, New South Wales. 28–93 m.

Remarks. *N. cauda* is most similar to *N. watasei* (Ohshima, 1915) from Japan. *N. watasei* also has body wall tables with 4 large and 4 small holes alternating around the table disc, and pedicel tables discs that curve away from the spire (Heding and Panning, 1954). *N. watasei* can be distinguished from *N. cauda* by the presence of a collar of papillae around the tentacles, irregular

rod ossicles with perforated ends in the tentacles, and the spire on the body wall tables which is four-columned at the base.

All other species of *Neocucumis* differ in having table ossicles with very irregularly-shaped discs, denticulate discs, or with more or fewer perforations on the disc.

The type specimens of *N. cauda* were dredged from coarse sediments.

Neocucumella Pawson, 1962

Diagnosis (modified from Pawson, 1962b). 20 dendritic tentacles, 5 outer pairs of large interrarial tentacles, 5 inner pairs of radial tentacles; pedicels in double rows on radii; body wall ossicles tables with regular oval discs with 4 large and 4 small holes, 0.05–0.10 mm long, spires with 2 pillars and terminal spines; pedicel ossicles endplates, perforated supporting plates and tables, sometimes with curved discs; tentacle ossicles rods with widened, perforated, denticulate ends; calcareous ring simple, without posterior prolongations, 10 plates, radials notched posteriorly and anteriorly, posterior ends divergent, anterior ends truncate, interradians small, inverted V-shaped, less than half as high as radials.

Type species. *Pseudocucumis bicolumnatus* Dendy and Hindle, 1907.

Remarks. Pawson (1962b) distinguished his new genus *Neocucumella* from *Neocucumis* by the presence of regular eight-holed tables, and rounded ends to the interrarial plates in the calcareous ring. Another significant difference is the additional supporting perforated plates which surround the endplate in the pedicels. The collar of papillae surrounding the tentacle crown in *Neocucumella* is also present in at least one *Neocucumis* species, *N. watasei* (Ohshima, 1915).

Of the other cucumariid genera which also possess two-spined tables, *Mensamaria* Clark, 1946 has 30 tentacles and *Amphicyclus* Bell, 1884 has 25.

Neocucumella fracta sp. nov.

Plates 2d, 10g–j, Figure 8e–l

Pseudocucumis bicolumnatus. — Joshua and Creed, 1915: 19.

Mensamaria bicolumnata. — H.L. Clark, 1946: 406.

Neocucumella bicolumnata. — Rowe, 1982: 467 [non *Neocucumella bicolumnata* (Dendy and Hindle, 1907)].

Material examined. Holotype. South Australia, Spencer Gulf, Point Lowly, 33°01'S, 137°48'E, 22 m, Sep 1987, RV "Ngerin", SAM K1797.

Paratypes. Upper Spencer Gulf, E of Monument Hill, 32°50'S, 137°49'E, 17 m, 7–20 Feb 1986, SAM K1817(1); E of Point Lowly, 33°00'S, 137°48'E, 24 m, Sep 1987, SAM K1792(1); Point Lowly, 33°01'S, 137°48'E, 22 m, Aug 1986, SAM K1796(1); 33°01'S, 137°50'E, 12 m, Sep 1987, SAM K1802(1); Fairway Bank, 33°02'S, 137°45'E, 18m, Feb 1987, SAM K1793(2).

Other material. South Australia, no locality or date, coll. Dr Verco, identified as *Pseudocucumis bicolumnata* by Joshua and Creed, 1915, SAM K1373(1); 14 lots from Upper Spencer Gulf, various stations, 32°50'–33°05'S, 137°40'–137°50'E, Feb 1986–Sep 1987, 10–24 m, SAM(5 and 14 'tails').

Victoria, eastern Bass Strait, 38°53.7'S, 147°55.2'E, 71 m, shell/sand, 17 Nov 1981, BSS stn 171, NMV F59214(1).

Description. Body (contracted, tentacles withdrawn) up to 32 mm long, diameter 7.5 mm; body rounded to slightly pentagonal in transverse section; long thin posterior end, frequently detached; lacking sole or modified ventrum; mouth anterior, anus posterior; 20 tentacles, 5 pairs large, 5 inner pairs small. Fur-like collar of numerous fine papillae around the tentacle ring, 0.5 mm long. Lacking oral valves and anal teeth. Pedicels in 2 rows on each radius; pedicels thin, up to 80 in each row; pedicels extend across long introvert; up to 15 small anal pedicels. Calcareous ring lacking posterior prolongations; 5 radial plates with anterior notch, narrowed waist, widened posterior end, wider than anterior end, with large notch; 5 interradials small, inverted V-shaped, with one anterior, 2 posterior blunt pointed corners. Dorsal madreporite. Usually single left lateral clongate tubular polian vesicle (one specimen, SAM K1796, with 4).

Body wall ossicles of one type. Abundant closely-situated tables; discs oval, regular, 8 perforations, typically 0.08 mm long; spires with 2 pillars, slightly tapered and joined distally, 0.04 mm high, typically with 8 blunt spines. Introvert with tables, some smaller and narrowly oval, some with more than 8 perforations, typically 0.06 mm long. Pedicels with endplates, up to 0.2 mm wide; curved supporting plates, elongate, curved, perforated, irregular, sometimes denticulate, typically 0.1 mm long, situated around endplates; tables with discs curved away from spire, narrower than body wall discs, up to 20 perforations, typically 0.08 mm long, spire 0.03 mm high. Tentacles with thin rods, rarely with short branches centrally or terminally,

some with up to 4 perforations terminally, some with clumps of small knobs, typically 0.08 mm long.

Colour (preserved). Uniform very pale yellow to white.

Reproduction. Sexes separate; male, female gonad tubules distinguishable in specimens collected in February. Gonad, gonoduct dorsal; gonad tubules not forked.

Etymology. From the Latin *fracta* (fragmentary), with reference to the number of regular posterior body ends collected.

Distribution. Spencer Gulf, South Australia, to eastern Bass Strait. 10–71 m.

Remarks. *N. fracta* is similar to the only other *Neocucumella* species, *N. bicolumnata* (Dendy and Hindle), known from New Zealand in 7–239 m. *N. bicolumnata*, as described by Dendy and Hindle (1907: 106) and Pawson (1963: 23; 1970: 32), differs in having consistently smaller body wall and tentacle ossicles, tentacle rods with many more terminal perforations, no pedicels on the introvert, and no curved table ossicles in the pedicel walls. The tables typically measure 0.06 mm across and 0.02 mm high. The tentacle rods, which have up to 20 terminal perforations, measure up to 0.06 mm long. *N. bicolumnata* specimens up to 90 mm long have been found, and are usually coloured red or brown in alcohol.

A specimen of *N. bicolumnata* from New Zealand (NZOI station B41, 13 mm long), identified by Pawson (see Pawson, 1970: 32), was examined for comparison. It is consistent with previous descriptions. It differs from *N. fracta* in the smaller size of the body wall tables, 0.06 mm long; larger endplates, up to 0.36 mm wide; absence of pedicel tables with curved discs; and the presence of a pointed "tooth" at the centre of the anterior notch of the radial plates in the calcareous ring. Introvert and tentacle features could not be confirmed because of the condition of the specimen.

The single Bass Strait specimen (NMV F59214) differs from the South Australian *N. fracta* material in having larger tentacle rods, up to 0.15 mm long, and smaller body wall tables, 0.06 mm long. The tables are similar in size to *N. bicolumnata*. The presence of pedicels on the introvert, the form of the tentacle rods, the presence of pedicel tables with irregular curved discs, and the absence of a radial plate "tooth" in

the anterior notch, are all consistent with the *N. fracta* types.

Joshua and Creed (1915) recorded a specimen (SAM K1373) of *N. bicornuata* collected by Dr Verey from South Australia. This specimen, upon examination, clearly belongs to the present species.

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Explanation of Plates

Plate 1 Figures a–h, ventrolateral views of holotypes, scale bar = 5 mm: a, *Pentocnus bursatus* gen. et sp. nov., NMV F57549, 6 mm long; b, *Cucuvitrum rowei* gen. et sp. nov., NMV F57356, 9 mm long; c, *Neocnus bimarsupis* sp. nov., NMV F54238, 5 mm long; d, *Squamocnus aureoruber* gen. et sp. nov., NMV F54244, 11 mm long; e, *Trachythyone candida* sp. nov., NMV F59200, 8 mm long; f, *Apsolidium alvei* sp. nov., SAM K1824, 54 mm long; g, *Trachythyone glebosa* sp. nov., SAM K1812, 12 mm long; h, *Ocnus occiduus* sp. nov., NMV F59212, 23 mm long.

Plate 2 Figures a–d, ventrolateral views of holotypes, scale bar = 5 mm: a, *Apsolidium handrecki* gen. et sp. nov., NMV F54391, 14 mm long; b, *Apsolidium densum* sp. nov., NMV F54237, 35 mm long; c, *Neocucumis cauda* sp. nov., NMV F57952, 12 mm long; d, *Neocucumella fracta* sp. nov., SAM K1797, 25 mm long.

Figures c–h, ossicles, scale bar = 0.1 mm: c–g, *Pentocnus bursatus* gen. et sp. nov.: c, body wall perforated plate, NMV F59207; f, body wall perforated plates, type series; g, tentacle ossicles, mainly irregular rods, type series; h, *Neocnus bimarsupis* sp. nov., tentacle rods, NMV F54387.

Plate 3 Figures a–g, ossicles of *Cucuvitrum rowei* gen. et sp. nov., scale bar = 0.1 mm: a, ventral body wall perforated plate with projecting knobs and connecting bars, holotype; b, dorsal body wall multi-layered ossicle, AM J10883; c, dorsal body wall knobbed perforated plates, NMV F59221; d, dorsal body wall multi-layered ossicles and knobbed plates, NMV F59221; e, dorsal body wall knobbed button-like ossicles, NMV F59221; f, ventral pedicel bar-like ossicles, holotype; g, tentacle ossicles, NMV F59221.

Plate 4 Figures a–h, ossicles of *Squamocnus aureoruber* gen. et sp. nov., scale bar = 0.1 mm: a, ventral body wall perforated plates with second-

ary developments, NMV F54704; b, dorsal body wall multi-layered ossicle, NMV F53793; c, dorsal body wall spinous cups, larger 0.04 mm long, NMV F53793; d, dorsal body wall knobbed button, cups, and part of a multi-layered ossicle, NMV F59220; e, ventral body wall and pedicel non-spinous cups, and flat and bar-like ossicles, NMV F54704; f, dorsal body wall knobbed button, NMV F53793; g, ventral pedicel flat and bar-like ossicles, NMV F59220; h, tentacle bar-like ossicles, NMV F59220.

Plate 5 Figures a–f, ossicles of *Trachythyone candida* sp. nov., scale-bar = 0.1 mm: a–b, dorsal body wall perforated plates, some denticulate, NMV F59215; c, ventral body wall cup, 0.05 mm long, holotype; d, ventral body wall cups, NMV F54701; e, ventral pedicel perforated plate, NMV F54701; f, tentacle ossicles, NMV F59215.

Figures g–j, ossicles of *Trachythyone glebosa* sp. nov., holotype, scale bar = 0.1 mm: g, dorsal lump perforated plate; h, dorsal lump irregular cups; i, ventral pedicel endplate and curved narrow perforated plates; j, tentacle bent bar-like ossicle and rosettes.

Plate 6 Figures a–i, ossicles of *Apsolidium handrecki* gen. et sp. nov., type series, scale bar = 0.1 mm: a, sole cups and button-like ossicles; b, sole lumpy and smooth button-like ossicles, cups, and curved pedicel plate; c, part of dorsal body wall multi-layered ossicle; d, side view of dorsal body wall developing cup, 0.05 mm wide; e, end view of dorsal body wall cup, 0.05 mm wide; f, ventral pedicel narrow perforated plates; g, ventral pedicel endplate; h, tentacle bar-like ossicles and mesh-like plate; i, tentacle rosettes.

Plate 7 Figures a–h, ossicles of *Apsolidium densum* sp. nov., scale bar = 0.1 mm: a, dorsal body wall multi-layered ossicle, NMV F53766; b, dorsal body wall large knobbed cup, NMV F53766; c, sole cups, NMV F53764; d, dorsal body wall smooth perforated plate, NMV F53766; e, dorsal body wall lumpy and smooth button-like ossicles, NMV F53764; f, tentacle rosette, NMV F53764; g, pedicel bar-like ossicles, NMV F53764; h, tentacle bar-like ossicles and mesh-like plates, NMV F53764.

Plate 8 Figures a–f, ossicles of *Apsolidium alvei* sp. n, holotype, scale bar = 0.1 mm: a, dorsal body wall large plate, button-like ossicles, and cups; b, ventral body wall narrow plates and cup; c, ventral body wall cups; d, ventral body wall

cups in side, end and ventral view; e, ventral pedicel endplate, thin perforated pedicel plates, and thick narrow body wall plates; f, tentacle bar-like ossicles.

Plate 9 Figures a–f, ossicles of *Ocnus occiduus* sp. nov., scale bar = 0.1 mm: a, dorsal body wall buttons, SAM K1811; b, dorsal body wall cups, SAM K1811; c, dorsal body wall perforated plate, SAM K1811; d, dorsal body wall bent bar-like ossicles, SAM K1811; e, pedicel bar-like ossicles, SAM K1816; f, tentacle bar-like ossicles, mesh-like plates, rosette and button, SAM K1816.

Plate 10 Figures a–f, ossicles of *Neocucumis cauda* sp. nov., type series, scale bar = 0.1 mm: a–c body wall and pedicel tables; d, introvert tables; e–f, tentacle plates.

Figures g–j, ossicles of *Neocucumella fracta* sp. nov., scale bar = 0.1 mm: g–h, body wall tables, holotype; i, pedicel tables, holotype; j, tentacle rods, SAM K1373.

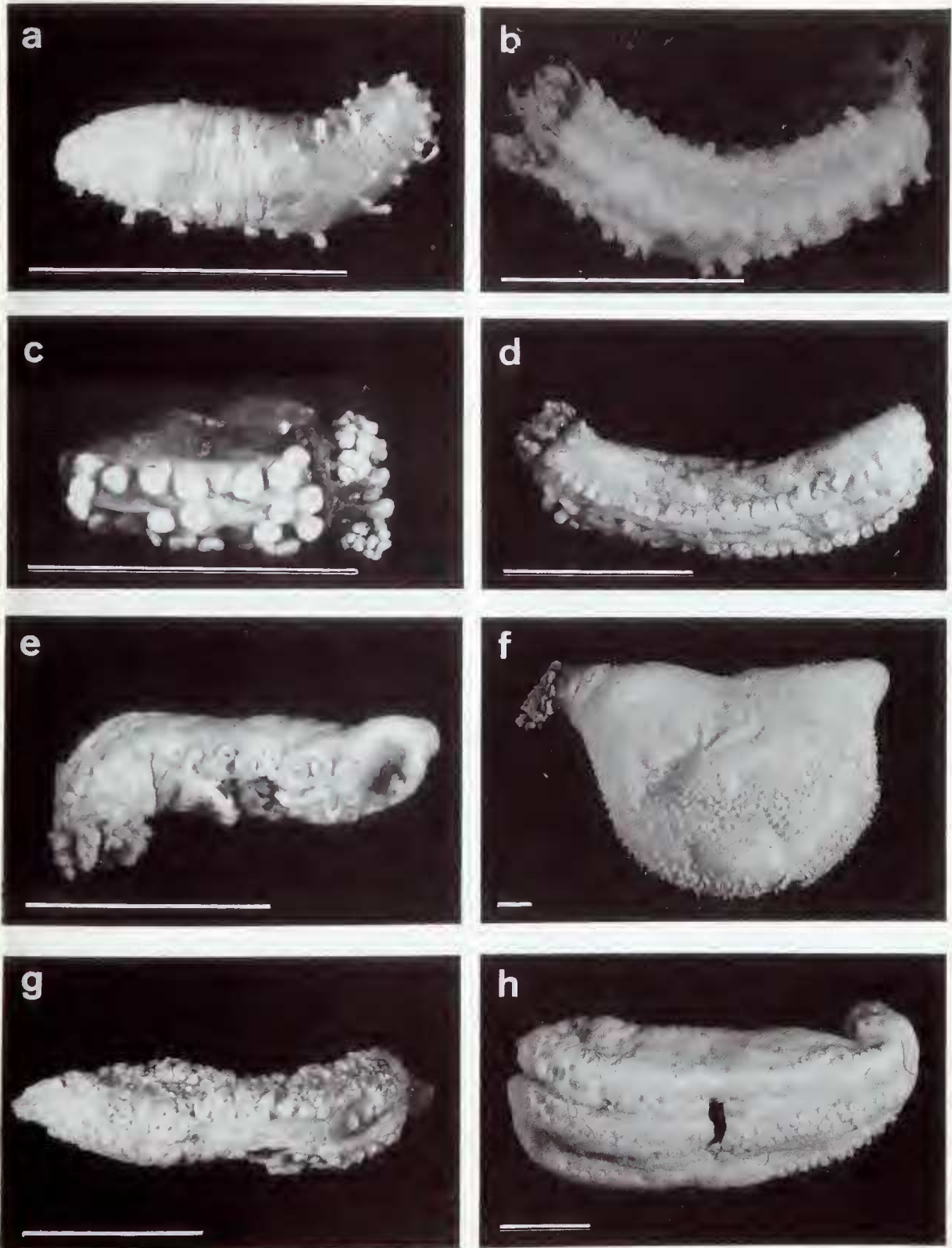
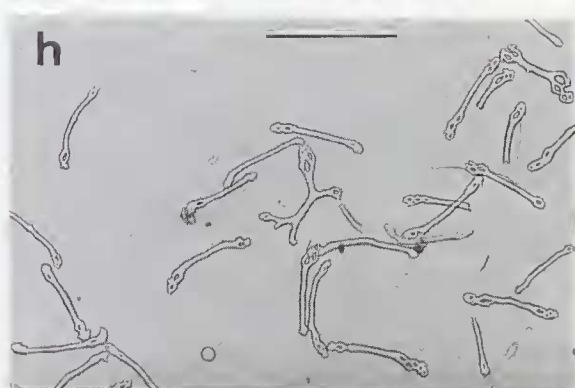
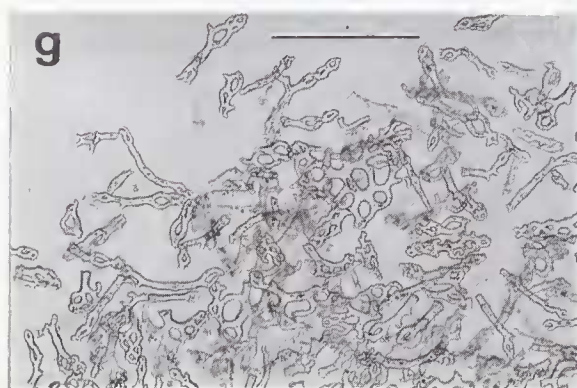
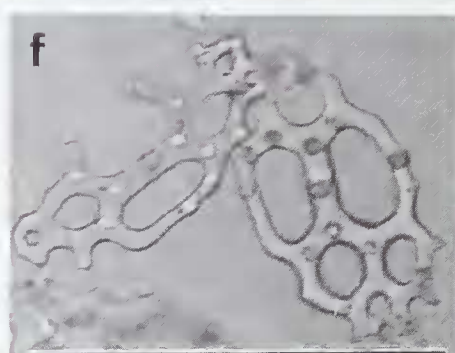
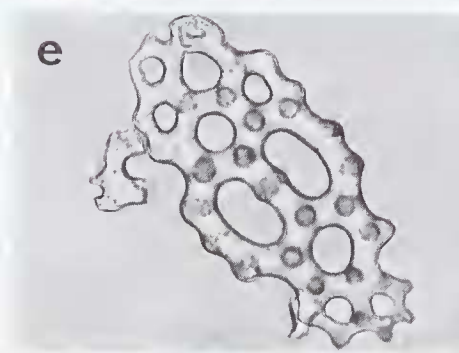
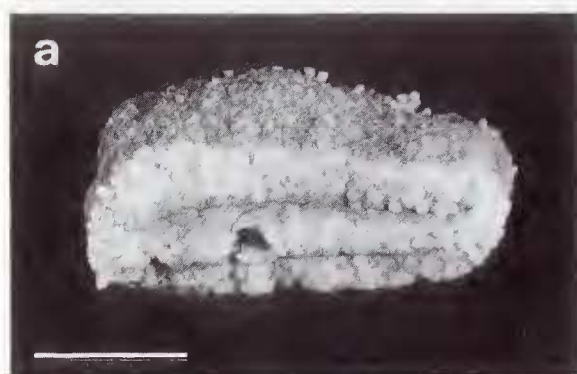
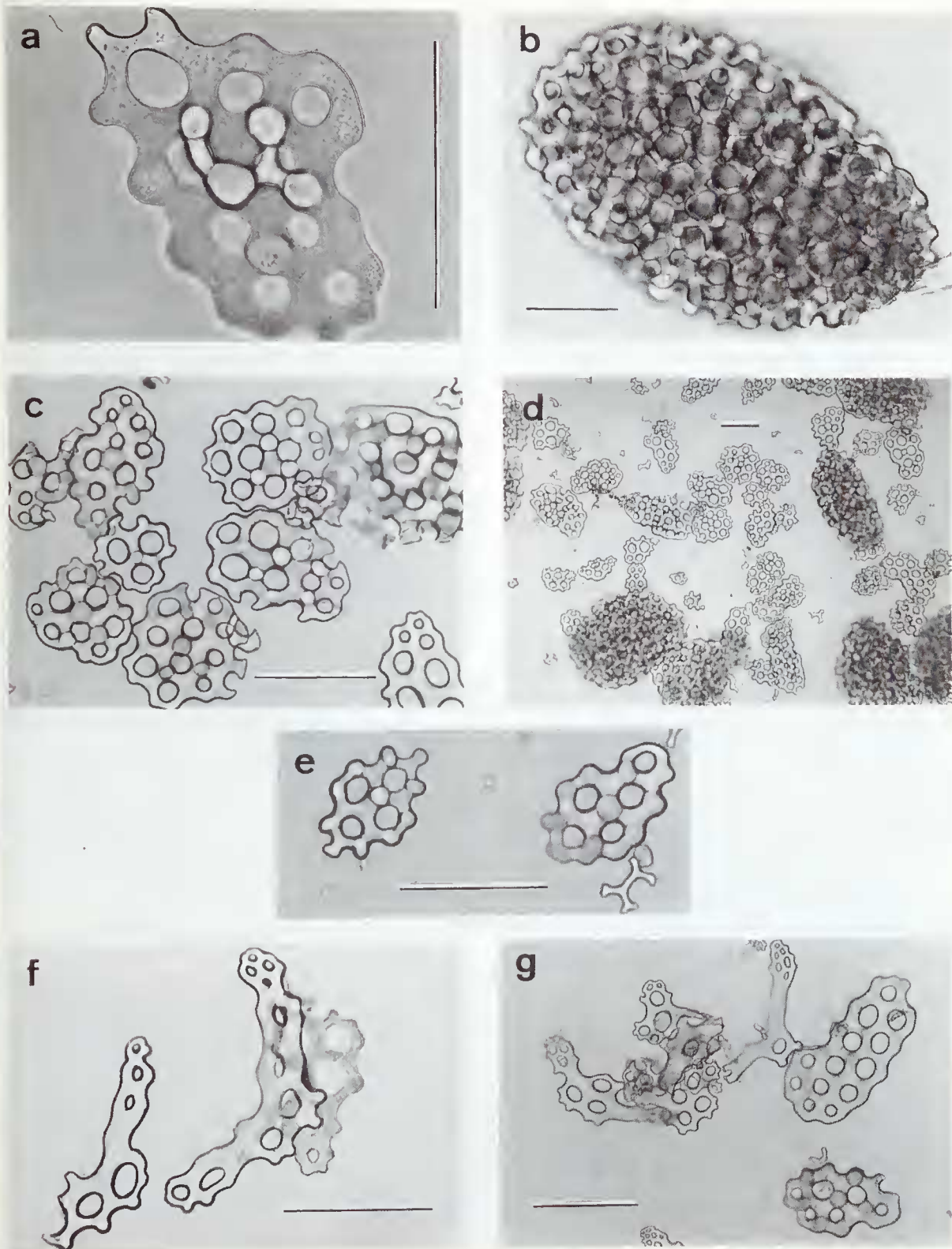
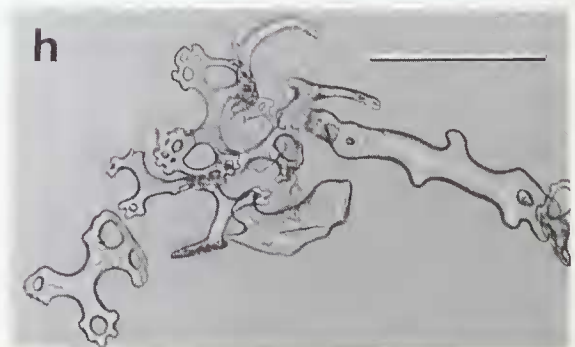
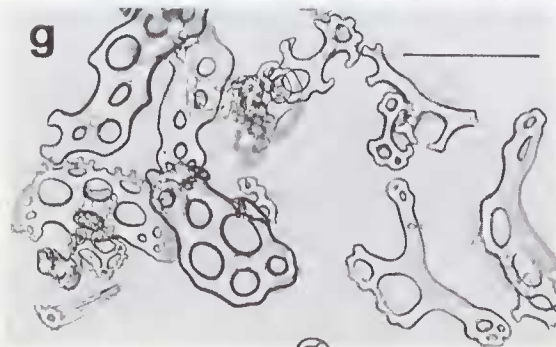
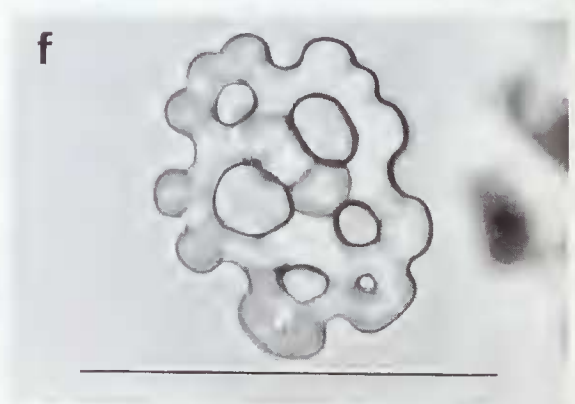
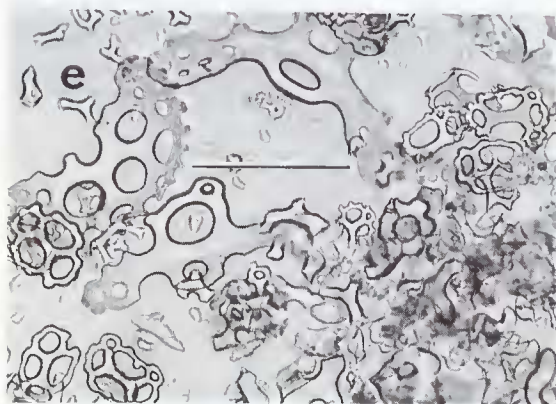
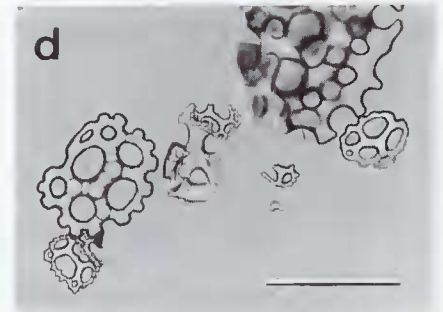
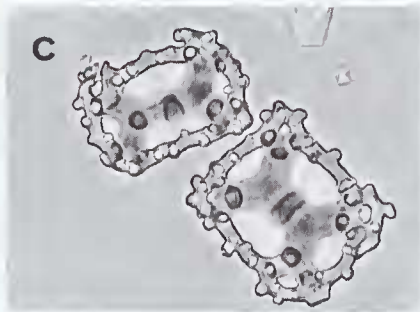
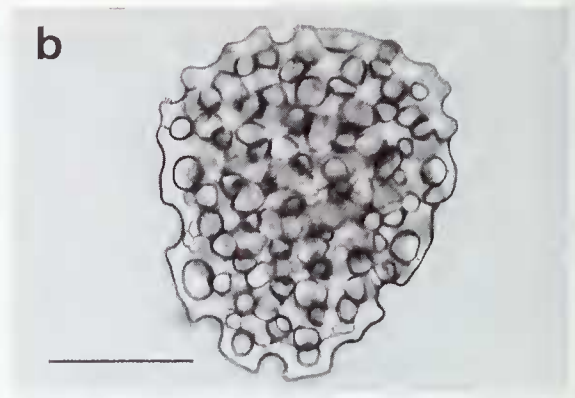
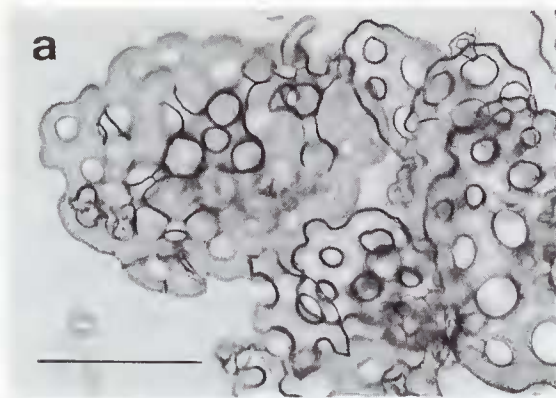
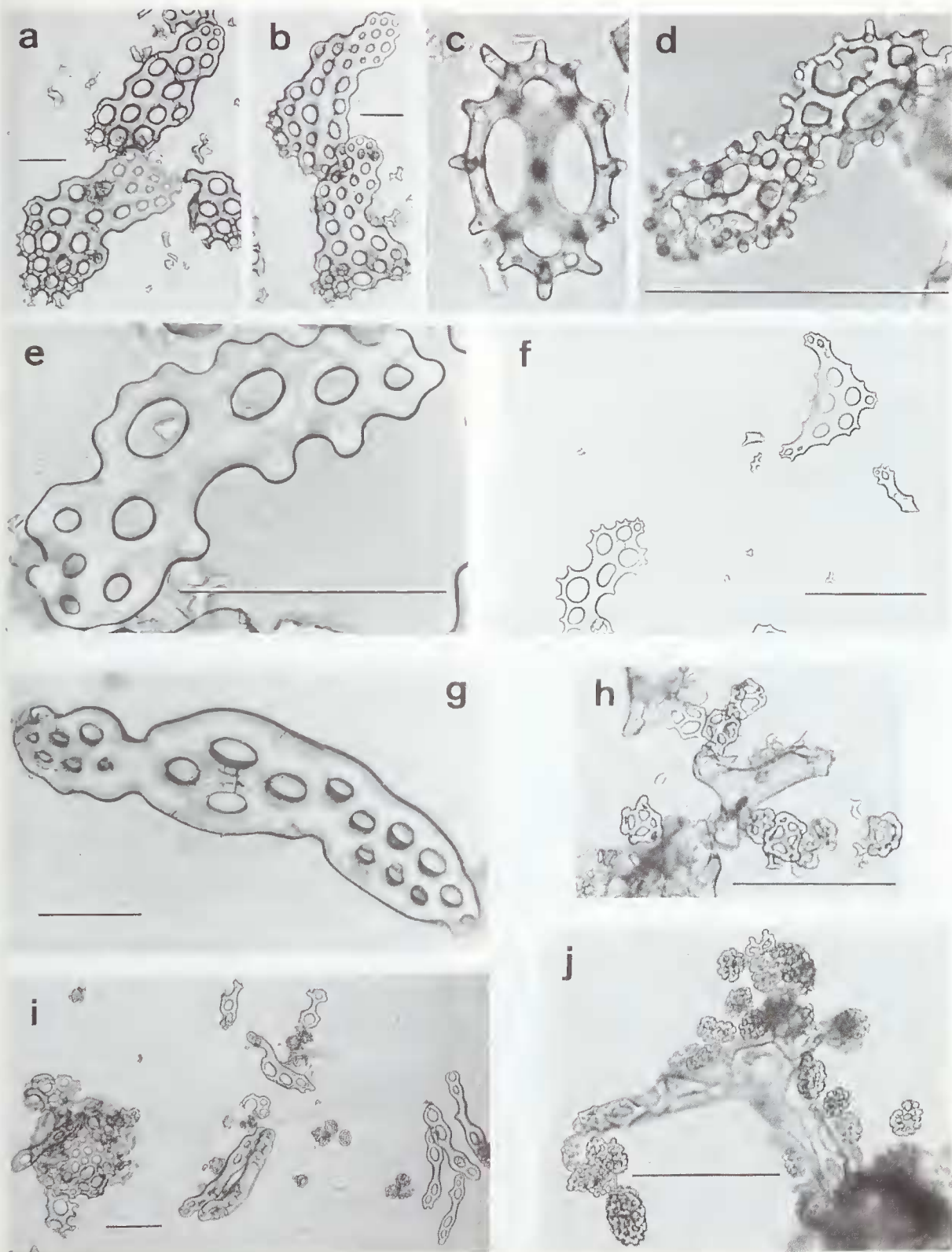


PLATE 1









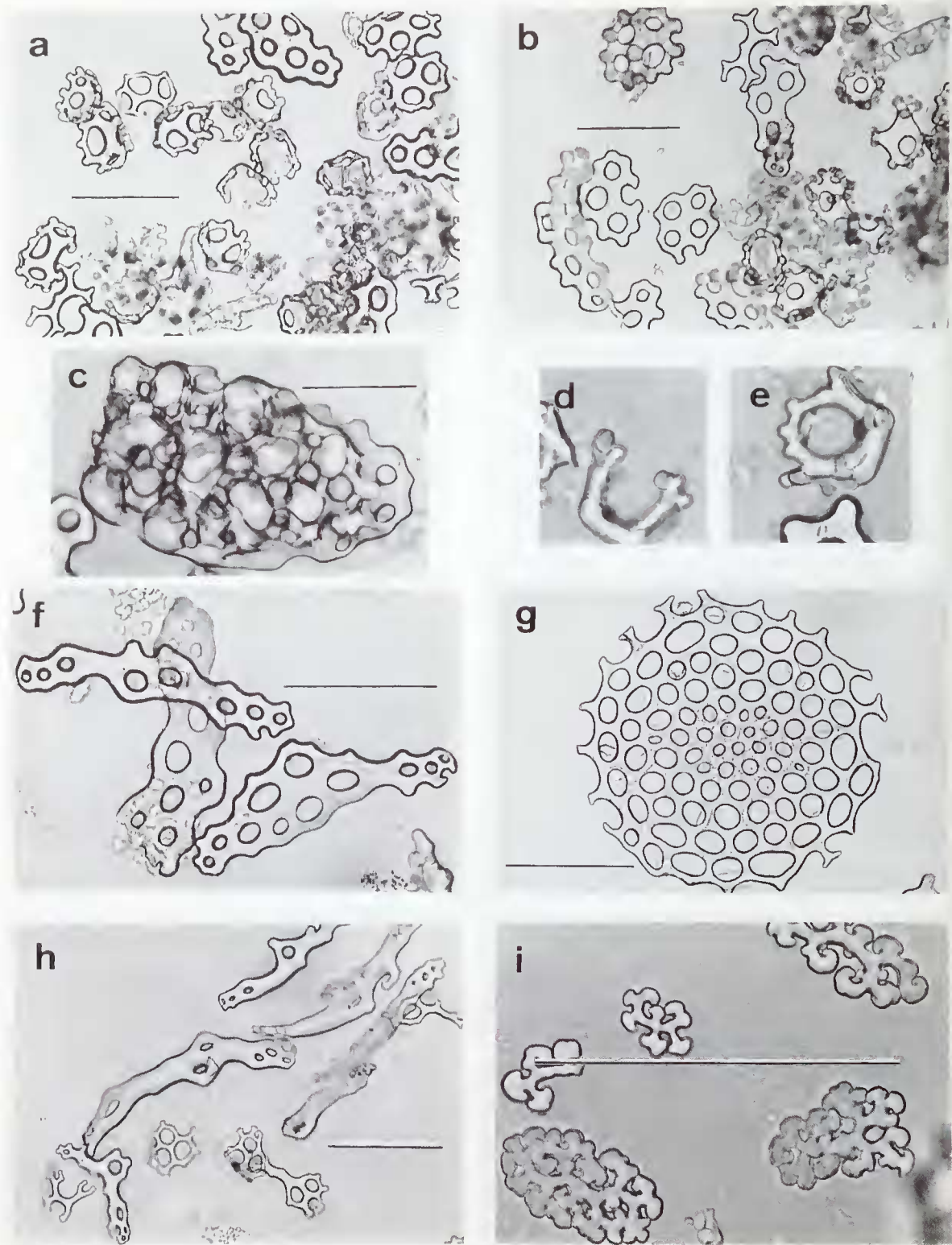


PLATE 6

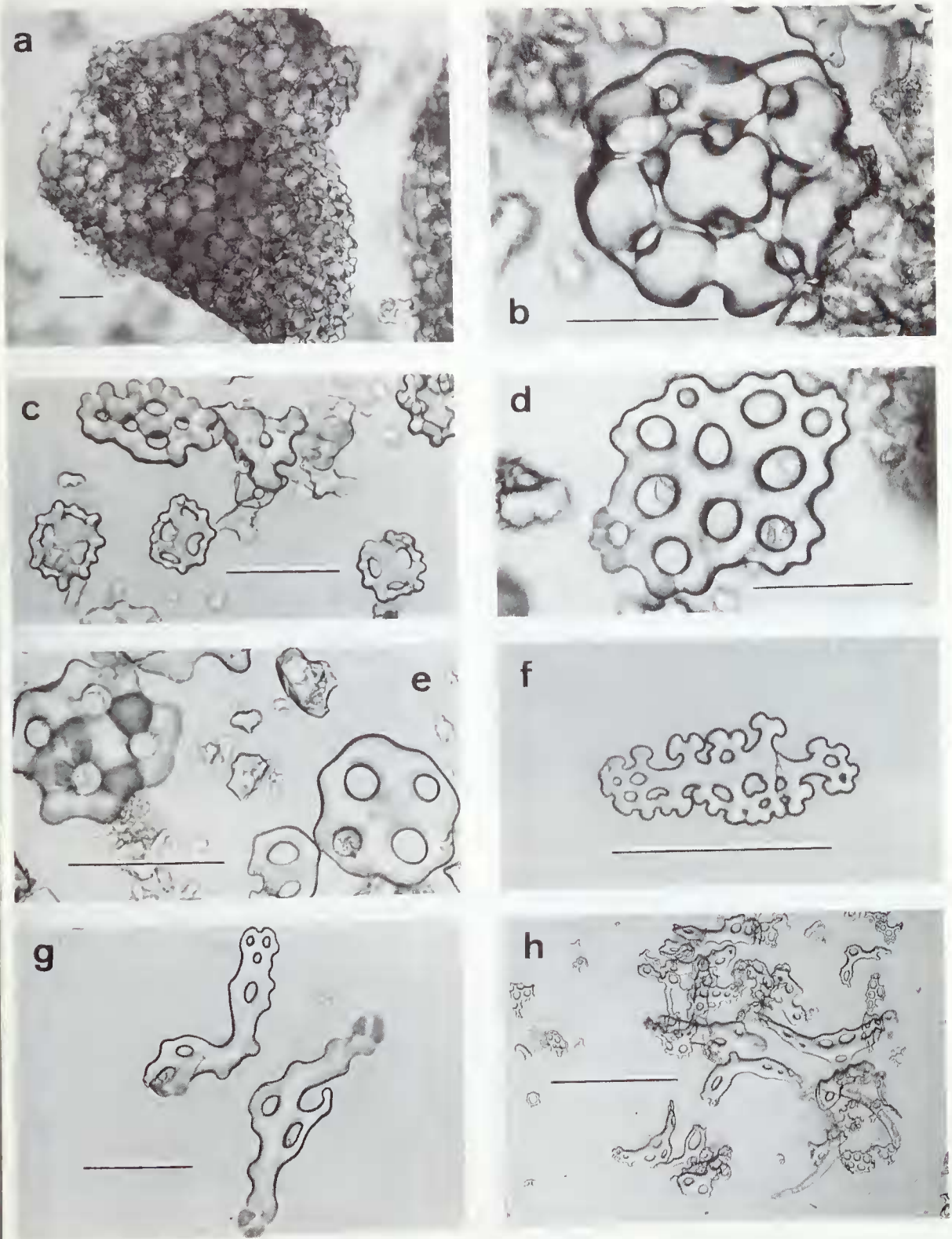


PLATE 7

